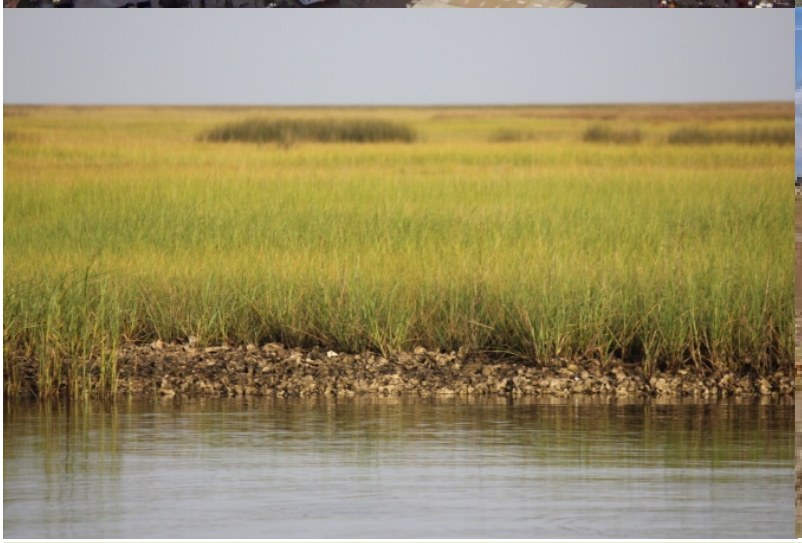
Southwest Coastal Louisiana



Draft Integrated Feasibility Report and Programmatic Environmental Impact Statement

US Army Corps of Engineers®

U.S. Army Corps of Engineers
Mississippi Valley Division
New Orleans District

December 2013

Hurricane Ike flooding in Delcambre, Louisiana.

Abstract

(*NEPA Required)

The Southwest Coastal Louisiana (SWC) project proposed by the U.S. Army Corps of Engineers, Mississippi Valley Division, New Orleans District (CEMVN), will provide nonstructural hurricane and storm surge damage risk reduction measures as well as ecosystem restoration features in the 4,700 square mile study area located in Calcasieu, Cameron, and Vermilion Parishes in southwest Louisiana. Impacts of both the National Economic Development (NED) and the National Ecosystem Restoration (NER) plans are described in this Draft Programmatic Environmental Impact Statement (DPEIS).

SWC communities are at increasing risk to storm surge flooding due to wetland loss, relative sea level rise, and land subsidence. The NED purpose of this project is to provide hurricane and storm damage risk reduction to reduce the risk of flood damages caused by hurricane and storm surges. Proposed measures of the NED nonstructural plan include residential structure elevation, flood proofing, and the acquisition of qualifying structures to reduce potential damages from future tropical storms and hurricanes.

The NER-related purpose of the SWC project is to significantly restore environmental conditions for the Chenier Plain ecosystem as more fully described in the LCA Ecosystem Restoration Study (2004). CEMVN proposes ecosystem restoration measures that include nine marsh restoration measures which would restore 8,579 acres and nourish 4,026 acres, resulting in 8,714 net acres; two hydrologic and salinity control measures to restore 6,092 net acres; five shoreline protection measures that protect 5,509 net acres of shoreline and which would span 266,884 linear feet; the preservation of the historic Sabine Lake oyster reef, and a Chenier reforestation program that includes invasive species control and planting seedling trees on 1,413 acres in multiple locations in Cameron and Vermilion Parishes.

There is a potential for beneficial direct, indirect and cumulative impacts to wetlands, wildlife, fisheries, and water quality, due to the implementation of the NER TSP. As this is a DPEIS, additional analysis will be conducted but at this point in the study process, we do not anticipate a need to mitigate for habitat impacts as a result of either the NED or the NER TSPs. Environmental Justice (EJ) requires the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies. There is a potential for negative adverse impacts and an inequitable distribution of environmental burdens to certain communities in the study area depending on how the nonstructural measures are applied. As this is a DPEIS, additional analysis and outreach to identified EJ communities would be conducted during project engineering and design and documented in supplemental NEPA reports in order to minimize any potential disproportionate impacts, and develop appropriate mitigation strategies if necessary. The study will be fully compliant with Executive Order 12898.

Comments: Please send comments or questions on this Draft PEIS to the U.S. Army Corps of Engineers, New Orleans District, Attention: Sandra Stiles, P.O. Box 60267, New Orleans, LA 70160-0267, by e-mail: SWCoastalAdmin@usace.army.mil or by Fax: (504) 862-1892. Please direct questions by telephone: (504) 862-1583. The official comment period closing date for this project would be 45 days from the date on which the Notice of Availability of this Draft PEIS appeared in the *Federal Register*.

The people, economy, environment, and cultural heritage of Southwest Louisiana are at risk from storm surge flooding. The area's low elevation, proximity to the Gulf of Mexico, subsiding lands, and rising seas, combine to cause coastal flooding, shore erosion, saltwater intrusion, and loss of wetland and chenier habitats. Future conditions are expected to worsen.

Congress has authorized two major water resources investigations in Southwest Louisiana. One is focused on reducing storm surge damages and the other is evaluating coastal ecosystem restoration. Planning to address storm surge concentrated on the communities north of the Gulf Intracoastal Waterway (GIWW), but considered measures for all at risk structures inside and outside of the coastal zone (this is relevant because of the Louisiana Coastal Zone Management Program). Ecosystem restoration planning falls exclusively in the coastal zone.

The area covers over 4,700 square miles of varying terrain in three parishes (Calcasieu, Cameron, and Vermilion). The major area physiographic divisions are the Gulf Coast Prairies and the Gulf Coast Marsh. Major hydrologic basins are the Mermentau River and Calcasieu-Sabine Lakes and the Teche/Vermilion Basin. Dominant water features are the Calcasieu, Sabine, Neches, Mermentau, and Vermilion rivers and Calcasieu, Sabine, Grand, and White Lakes. Man-made channels are the Sabine-Neches Waterway, Calcasieu Ship Channel, GIWW, Mermentau Ship Channel, and Freshwater Bayou Canal. The channels and waterways, except for the GIWW, are oriented north to south along the coast.

The GIWW is the longest channel crossing the area. It runs generally along the state coastal zone boundary. Area water control structures are the Calcasieu and Leland Bowman Locks, the Freshwater Bayou Canal Lock, the Schooner Bayou Canal Structure, and the Catfish Point Control Structure. Key highways are LA-82 and LA-27 and I-10. Population centers are found mainly north of the GIWW. Lake Charles, Sulphur, and Abbeville are the largest towns.

The planning team used information from prior Federal, state, and local efforts to narrow the study focus to the most critical remaining areas. Systemwide problems and opportunities were used to identify and define site specific problems and opportunities. Problems include:

- Flooding from tidal surge and waves associated with hurricanes and tropical storms.
- Increased flood durations in wetlands, resulting in wetland loss.
- Erosion of channel banks and shorelines, resulting in wetland loss.
- Deforestation and mining of chenier ridges.

Opportunities to solve the problems include:

- Incorporate structural and nonstructural coastal storm damage reduction solutions to reduce the risk of damages and prevent loss of community cohesion.
- Improve internal system hydrology to restore wetlands.
- Manage salinity levels to maintain fresh and intermediate marsh.
- Reduce bank and shoreline erosion.
- Prevent loss of significant historic and cultural resources.

The team developed five specific planning objectives:

- *Objective 1.* Reduce the risk of damages and losses from storm surge flooding.
- *Objective 2.* Manage tidal flows to improve drainage and prevent salinity from exceeding fresh marsh and intermediate marsh levels.
- *Objective 3.* Increase wetland productivity in fresh and intermediate marshes to maintain function by reducing the time water levels exceed marsh surfaces.
- *Objective 4.* Reduce shoreline erosion and stabilize canal banks to protect wetlands.

- *Objective 5.* Restore landscapes, including marsh, shoreline, and cheniers to maintain their function as wildlife habitat and improve their ability to serve as protective barriers.

Planning constraints that are to be avoided or minimized were identified:

- *Commercial navigation.* The Calcasieu and Sabine ship channels and the GIWW carry significant navigation traffic. Shipping delays would result in negative National Economic Development (NED) impacts, as would features that impair the ability of authorized navigation projects to fulfill their purpose.
- *Federally threatened and endangered species and their critical habitats.* Construction windows for resident species overlap and/or may include the entire year: Piping Plover, Gulf Sturgeon, Red-Cockaded Woodpecker, Red Knot, Whooping Crane, West Indian Manatee, and several species of sea turtles.
- *Essential fish habitat (EFH), especially intertidal wetlands.* Conversion of one EFH type to another should be done without adversely impacting various fish species. For example, conversion of shallow open water EFH to marsh EFH.
- *Historic and cultural resources.* Archeological sites and standing structures have been identified near the alternatives, including properties listed on the National Register of Historic Places, as well as potentially eligible sites and structures.

National Economic Development Planning

Hurricane and storm damage risk reduction measures were developed and screened using preliminary costs and benefits to identify a focused array of NED alternatives. In addition to the no action plan, there are two stand-alone nonstructural plans. The focused array contained three levee alignments in the Lake Charles area, and three levee alignments around the towns of Abbeville, Delcambre, and/or Erath.

<u>NED Focused Array</u>:

- No Action.
- Lake Charles Eastbank.
- Lake Charles Westbank Sulphur Extended.
- Lake Charles Westbank Sulphur South.
- Nonstructural Justified Reaches Plan.
- Delcambre/Erath.
- Abbeville to Delcambre.
- Abbeville.
- 100-year Floodplain Nonstructural Plan.

Computer models estimated damage probability relationships for risk reduction reaches. Construction, relocations, mitigation, operations, maintenance and repair cost estimates were prepared. Alternatives were screened at risk reduction levels based on equivalent annual values of damages avoided.

The NED Final Array includes:

- No Action.
- 100-year Floodplain Nonstructural Plan
- Nonstructural Justified Reaches Plan.

The NED Tentatively Selected Plan (TSP) consists of nonstructural measures, such as elevating, flood proofing, and acquiring structures to reduce storm damage risks in lower density towns and rural areas. The analysis found eleven areas where benefits outweigh costs of nonstructural measures for residential and commercial structures (excluding industry and warehouses). The study did not identify any levee alignments as justified risk reduction options. Details of the NED TSP are provided below (these will be refined for the final report):

- The Nonstructural Justified Reaches Plan would include but not be limited to:
  - Elevating, flood proofing, and acquiring structures.
- The plan is based on justified economic reaches including:
  - 3,915 total impacted structures in 2025.
  - $4.1 million in expected annual net benefits.
  - $388 million total costs.

National Ecosystem Restoration Planning

NER plan screening was based on monetary and non-monetary evaluations. Preliminary costs and benefits for marsh restoration, shore protection, chenier reforestation and water control were estimated. Screening criteria included planning constraints; support for objectives; measure effectiveness; and below average efficiency. Measures that did not meet the screening criteria were retained only in limited instances in which they supported critical adjacent features.

Alternative plans were created by combining measure types into comprehensive strategies. The measures were hydrologic and salinity control, marsh restoration, shore protection, and chenier reforestation. The focused array contains a no action comparison and 27 other plans based on eight strategies.

NER Strategies:

- No Action.
- Large Integrated Restoration.
- Moderate Integrated Restoration (Hydrologic Emphasis).
- Moderate Integrated Restoration, including Gum Cove.
- Small Integrated Restoration.
- Interior Perimeter Control.
- Marsh and Shoreline (Minimal Hydrologic & Salinity Control).
- Entry Salinity Control (Calcasieu Measure #7).

Scales and combinations of these strategies were developed resulting in 28 alternatives in a focused array. Benefits in the Calcasieu-Sabine Basin were considered separately from the Mermentau/Teche-Vermilion Basin. Benefits were also considered jointly as comprehensive plans. Alternatives were evaluated for cost effectiveness and incremental costs.

The NER TSP is Small Integrated Restoration, a comprehensive ecosystem restoration plan addressing land loss problems and ecosystem degradation. The TSP is cost effective, and is the least cost comprehensive best buy plan. The NER TSP will minimize land loss; enhance plant productivity by reducing major stressors; and will reinforce and protect critical landscape features. Details of the NER TSP are:

- Nine marsh restoration measures.
  - Create 8,579 acres & nourish 4,026 acres, resulting in 8,714 net acres.
- Two hydrologic and salinity control measures.
  - Protect 6,092 net acres.
- Five shoreline protection measures.
  - Protect 5,509 net acres adjacent to 266,884 linear feet of shoreline.
- Preserve the historic Sabine oyster reef.
- Chenier reforestation program.
  - Plant trees on 1,413 acres in Cameron & Vermilion parishes.
  - Removal of certain invasive species.

- Preliminary Estimated Cost: $1,300,000,000.

The Calcasieu Ship Channel salinity control structure was evaluated as a combinable strategy and standalone plan to assess salinity control benefits. Potential salinity control measures on the Calcasieu and Sabine ship channels need more analysis and are not part of the TSP. The study area is large and diverse and planning focused only on critical areas. Other efforts are needed to address additional environmental needs. These additional needs may be addressed by other programs or in future investigations.

The impacts described this EIS are programmatic in nature. Subsequent NEPA documents will analyze in detail site specific project(s) impacts prior to implementation

Over the next few months a public comment period will be conducted along with technical, peer and policy reviews. Additional feasibility work will be completed on engineering, cost estimates, environmental, economic, real estate and construction needs of the plan. Review results and feasibility details will be included in a final report that will be made available for state and agency and public review before the Chief of Engineers makes a final project recommendation.

INTRODUCTION

The low elevation and proximity to the Gulf of Mexico put the unique environment and cultural heritage of southwest Louisiana communities at risk from storm surge flooding and coastal erosion. Land subsidence and rising sea level is expected to increase the potential for coastal flooding, shore erosion, saltwater intrusion, and loss of wetlands and chenier habitats.

Purpose of Action and Scope (*NEPA Required)

The study purpose is to evaluate coastal storm flood damages and coastal ecosystem degradation in Cameron, Calcasieu, and Vermilion parishes in Louisiana. The intent is to develop potential solutions to these water resource problems. This is an interim response to the study authority. The impacts described here are programmatic in nature. Subsequent NEPA documents will analyze in detail site specific project(s) impacts prior to implementation.

Federal Objectives

The Federal objective of water and related land resources planning is to provide the greatest net contribution to national economic development (NED) consistent with protecting the Nation's environment, pursuant to national environmental statutes, applicable executive orders, and other Federal planning requirements. The ecosystem objective is to contribute to national ecosystem restoration (NER) by restoring function and structure to significant ecological resources.

1.0 PROJECT SETTING

This chapter describes the historic and existing conditions of the affected environment and forecasts the "future without-project conditions" which provides the basis for plan formulation. Additional impact analysis on important resources is further explained in appendix A**.** Further analysis on the TSP will be developed in greater detail during the feasibility level analysis phase.

1.1 Affected Environment (*NEPA Required)

Study Area

The study area (Figure 1-1) is located in southwest Louisiana and includes all of Calcasieu, Cameron and Vermilion parishes and small portions of Beauregard, Jefferson Davis and Iberia parishes encompassing approximately 4,700 square miles.

Cameron Parish is located in the southwest corner of Louisiana. The southern boundary of the parish is the Gulf of Mexico. Eighty-two percent of Cameron Parish is coastal marshes. Geographically, it is one of the largest parishes in Louisiana. The parish is chiefly rural and the largest communities are Cameron and Hackberry. Cameron is located along LA-82, while Hackberry is located along LA-27. Other smaller communities include Creole, Johnsons Bayou, and Holly Beach.

Calcasieu Parish is located due north of Cameron Parish. The town of Lake Charles is the parish seat, which is the largest urban area in the study area. Only a small portion of the parish is located in the coastal zone.

Vermilion Parish is located due east of Cameron Parish. The southern boundary of the parish is the Gulf of Mexico. Large expanses of Vermilion Parish are open water (lakes, bays, and streams). Approximately 50 percent of the land is coastal marshes. The parish is chiefly rural and the town of Abbeville is the parish seat as well as the largest urban area in the parish. Other communities include Delcambre, Kaplan, and Gueydan, which are all located along LA Hwy 14 in the northern part of the study area. Pecan Island and Forked Island are smaller communities,

both located along LA Hwy 82 in lower Vermilion Parish. Located along LA Hwy 333, Intracoastal City is the nearest access to Vermilion Bay and the Gulf of Mexico in this region and supports the area's oil and shrimp industries

Geomorphic and Physiographic Setting

The area is characterized by extensive coastal marshland interrupted by forests atop relict chenier ridges and natural ridges. The cheniers are unique geological features that are critical components of the ecology. Cheniers and natural ridges were formed over thousands of years by the deltaic processes of the Mississippi River and other streams. The chenier ridges run laterally to the modern shoreline and rise above the surrounding marshes by as little as a few inches or as much as 10 feet (Byrne et al 1959). These ridges can range from 2 to 15 feet thick and from 100 to 1,500 feet wide with some ridges extending along the coast for a distance of up to 30 miles. Cheniers were created during the Pleistocene by river sediments being pushed westward by shoreline currents in the Gulf of Mexico (Gould and McFarlan 1959). Natural ridges were formed by the repeated overbank flood sedimentation of rivers in southeast Louisiana (Fisk 1944). Principally, the rivers involved in creating these natural levees are past distributaries of the Mississippi River.

The main physiographic zones of the Chenier Plain include the Gulf Coast Marsh, Gulf Coast Prairies, and Forested Terraced Uplands. The Gulf Coast Marsh is at or near sea level and borders the Gulf of Mexico and most of the large lakes are in this area. The Gulf Coast Prairie extends from the central part of Vermilion and Cameron Parishes into the southern part of Calcasieu Parish, while the Forested Uplands, which occur at or near 25-foot elevation, are located in the northern part of Vermilion and Calcasieu Parishes. Louisiana's coastal prairies, once encompassing an estimated 2.5 million acres in the southwest portion of the state, now are considered critically imperiled with less than 600 acres remaining.

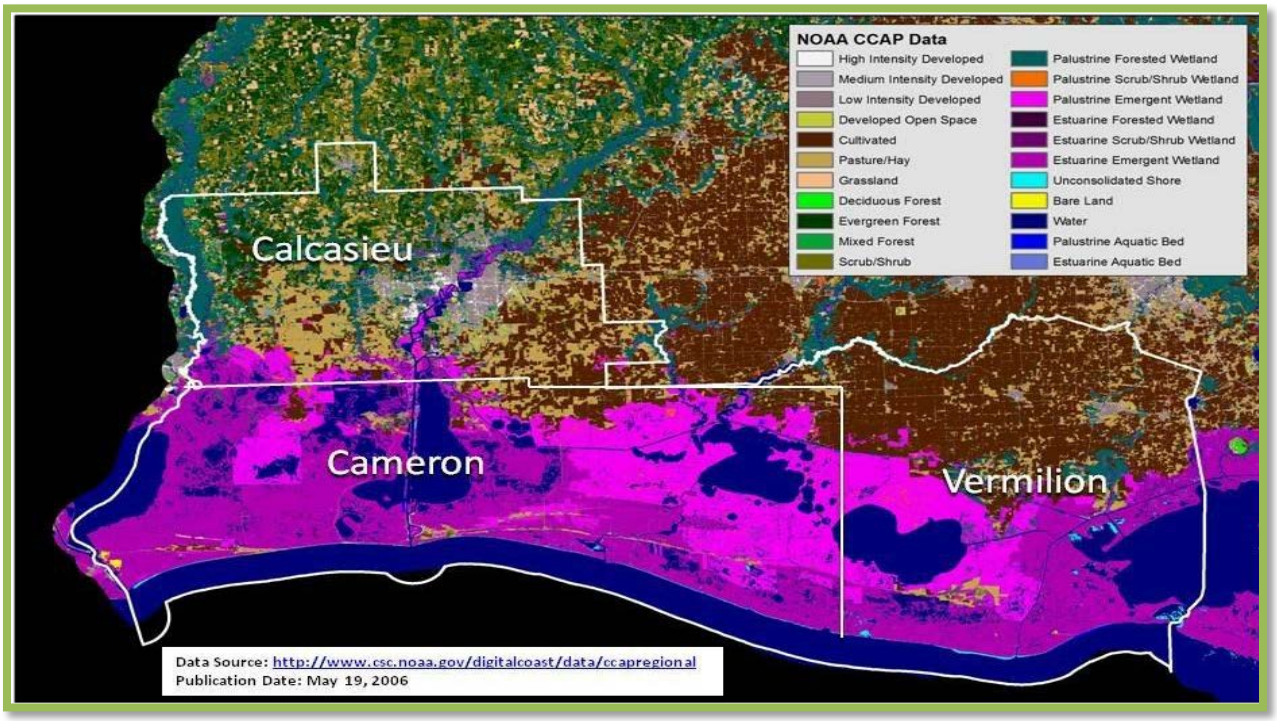


Figure 1-1: Study area map.

Climate

The climate is subtropical marine with long humid summers and short moderate winters. The average temperatures range from 59 to 78°F; with August being the warmest and December the coolest. Average annual rainfall is 57 inches; with June the wettest and April the driest month (Source: http://www.srh.noaa.gov/lch/?n=KLCH, accessed August 30, 2013). During the summer, prevailing southerly winds produce conditions favorable for afternoon thundershowers. In the colder seasons, the area is subjected to frontal movements that produce squalls and sudden temperature drops. River fogs are prevalent in the winter and spring when the temperature of the major waterbodies are somewhat colder than the air temperature. Since 1865 a total of 16 hurricanes have made landfall within 65 nautical miles of Lake Charles (source:http://csc.noaa.gov/hurricanes/#app=6078&7239-selectedIndex=0&3722-selectedIndex=0, accessed August 30, 2013).

Land cover classifications from the Louisiana Coastal Area (LCA) habitat dataset for calendar year 2000 are presented in Table 1-1 and appendix A. The 2000 LCA habitat data composition does not cover the portion of the study area north of the coastal zone (USGS 2013).

Table 1-1: Year 2000 area habitat classification.

Habitat Class	Acres	Percent of Project Area
Water	286,086	9.79%
Water - Fresh Zone	73,262	2.51%
Water - Intermediate Zone	84,736	2.90%
Water - Brackish Zone	49,896	1.71%
Water - Saline Zone	5,309	0.18%
Water - Swamp Zone	0	0.00%
Fresh Marsh	336,406	11.51%
Intermediate Marsh	310,577	10.62%
Brackish Marsh	177,369	6.07%
Saline Marsh	35,518	1.22%
Non-wetlands	15,651	0.54%
Wetland Forest	16,208	0.55%
Upland Forest	7,709	0.26%
Swamp	0	0.00%
Wetland Shrub/Scrub	17,076	0.58%
Upland Shrub/Scrub	10,745	0.37%
Agriculture/Pasture	67,842	2.32%
Developed	7,211	0.25%
Barren	9	0.00%
*Out of Analysis	1,421,582	48.63%
Total Acres	2,923,194	

*Out of analysis—this area, primarily north of the Coastal Zone, was not included in the original data set from which the data is derived.
(source: USGS Map ID USGS-NWRC 2014-11-0001 Map Date: October 18, 2013.)

1.2 Human Environment

Communities include the cities of Lake Charles and Sulphur; the towns of Vinton and Iowa in Calcasieu Parish, Cameron, Grand Lake, Hackberry, and Grand Chenier in Cameron Parish;

and the city of Abbeville, the towns of Erath, Kaplan, and Pecan Island in Vermilion Parish, and the town of Delcambre in Vermilion and Iberia parishes. These parishes have historically suffered extensive damage from hurricanes and tropical storms due to insufficient hurricane and storm damage risk reduction features. The impact of preparing for, mitigating, and recovering from these damages has placed a significant physical and emotional burden on both individuals and communities. Most recently, Hurricanes Rita (2005) and Ike (2008) caused significant damage to homes and businesses. In this section, socioeconomic and other social effects (OSE) data for Calcasieu, Cameron, and Vermilion Parishes provide a context from which to evaluate potential effects of the proposed action.

1.2.1 Population and Housing

Table 1-2 shows the population trend in the three-parish area from 1970 to 2012. Population increases between 2000 and 2010 reflect similar growth patterns state-wide over this period. Population in the three-parish area in 2012 was 259,918, although there was a decline of population in Cameron Parish from 2000 to 2012.

Table 1-2: Population in the study area.

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	145,415	167,223	168,134	183,577	192,768	194,493
Cameron	8,194	9,336	9,260	9,991	6,839	6,702
Vermilion	43,071	28,458	50,055	54,014	57,999	58,723
Total	**196,680**	**205,017**	**227,449**	**247,582**	**257,606**	**259,918**

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013)

The trend in household formation, shown in Table 1-3, parallels the growth in population. Most households are located in the metropolitan areas which include: Lake Charles in Calcasieu Parish; Cameron (which serves as the seat of government in Cameron Parish; and Abbeville located in Vermilion Parish.

Table 1-3: Households (in thousands) in the study area.

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	42.1	56.8	60.4	68.6	70.6	72.2
Cameron	2.3	3.0	3.1	3.6	2.5	2.4
Vermilion	12.8	16.3	17.7	19.9	21.1	21.6
Total	**57.2**	**76.1**	**81.3**	**92.1**	**94.2**	**96.2**

Sources: U. S. Census, 2010 and U.S. Census Abstract, 2013)

According to the Federal Emergency Management Agency (FEMA 2013), flood claims from all sources for the three-parish area between 1978 and 2012 totaled $420,900,000 (Table 1-4).

Table 1-4: Summary of flood claims data for the period 1978 to 2012.

Parish	Claims	Total Nominal Dollar Amount (in millions)	Average Amount per claim
Calcasieu	4,008	$132.0	$32,930
Cameron	3,061	$173.5	$56,679
Vermilion	3,218	$115.4	$35,860
Total	**7,712**	**$420.9**	**$54,574**

1.2.2 Employment, Business, and Industrial Activity

Growth is highly dependent upon the major employment sectors. With the exception of the city of Lake Charles in Calcasieu Parish, most of the land is sparsely populated. However, the area is rich in natural resources and industrial infrastructure. The economy of the coastal communities is centered on fishing, shrimping, and offshore oil services. The agricultural land located 30 to 40 miles inland is used for rice, sugar cane, and livestock production. The northern-most portion is heavily forested and supports a substantial timber industry. Lake Charles, which is the population center of the region, is the home of large oil refineries, petro-chemical plants, a deep-water port, McNeese State University, and casinos along the lakefront.
Table 1-5 shows the growth of non-farm employment. The leading employment sectors are education, healthcare, petroleum production, and petrochemical refining. Other significant employment sectors include education, manufacturing, accommodations and social services, and retail trade. Employment growth was steady from 1970 to 2012 for Calcasieu and Vermilion parishes, although employment in Cameron parish declined since 2000, and is reflected in the population estimates previously described.

Table 1-5: Non-farm employment in the study area.

Parish	1970	1980	1990	2000	2010	2012
Calcasieu	41.1	67.0	69.0	84.6	87.9	93.3
Cameron	2.8	4.4	4.1	3.9	2.6	2.7
Vermilion	9.4	16.6	13.3	14.7	15.5	16.9
Total	53.3	88.0	86.4	103.2	106.0	112.8

Source: Moody's 2013

1.2.3 Public Facilities and Services

Public facilities and services have historically grown to meet population demands. The area includes a mixture of community centers, schools, hospitals, airports, colleges, and fire protection. The Port of Lake Charles is a key center for international trade, and is among the top 15 busiest port in the nation. A total of 603 public and quasi-public buildings were specifically inventoried in 2012.

1.2.4 Transportation

The transportation infrastructure includes major roads, highways, railroads, and navigable waterways that have developed historically to meet the needs of the public. Interstate 10 (I-10), an east-west bi-coastal thoroughfare that connects Houston and Baton Rouge, crosses the northern part of the area and is a primary route for hurricane evacuation and post-storm emergency response. US-165, another evacuation and emergency response route, is located north of I-10. Most of I-10 is either at or just below the 100-year floodplain. Other major highways include US-13 and US-26, which runs north-south and intersects I-10 in the northeastern portion of the parishes.

Other modes of transportation include water transport along the GIWW and the Sabine and Calcasieu Rivers, all of which accommodate ocean-going vessel and barge traffic. Rail and aviation facilities are spread throughout.

During Hurricanes Rita and Ike, portions of I-10 were inundated by a combination of storm surge and rainfall. This interfered with emergency service access and prevented local and regional residents from returning to their primary residences and businesses. This delay in repopulation results in additional emergency costs, due to the longer time periods required for sheltering residents until the area was made safe to return.

1.2.5 Community and Regional Growth (Income)

Community and regional growth primarily track population and employment trends that were described in the preceding sections. Table 1-6 shows per capita growth in income since 2000.

Table 1-6: Per capita income in the study area.

Parish	1990	2000	2010	2012
Calcasieu	$15,489	$22,528	$37,403	$40,892
Cameron	$13,011	$17,935	$31,136	$35,068
Vermilion	$29,729	$18,669	$28,274	$29,729

1.2.6 Tax Revenue and Property Values

Historically, damages from storm surge events have adversely impacted business and industrial activity, agricultural activity, and local employment and income, which then led to commensurate negative impacts to property values and the tax base upon which government revenues rely. As in other developed communities, the presence of high flood risk has reduced property values since the cost of repairing flood damages (whether directly by property owners or through claims made through the National Flood Insurance Program (NFIP) for which annual premiums are charged) increases the long-term cost of property ownership. Measurement of this loss is problematic since the market price of properties capture an extensive array of factors such that the contribution of flood risk cannot be directly ascertained.

Information for 46,860 residential and 4,997 non-residential structures was collected to assist in evaluating the impacts of flood risk under existing and future conditions. Currently, the median depreciated replacement value of housing units is $115,684 in 2012 price prices.

1.2.7 Community Cohesion

Community cohesion is based on the characteristics that keep the members of the group together long enough to establish meaningful interactions, common institutions, and agreed upon ways of behavior. These characteristics include race, education, income, ethnicity, religion, language, and mutual economic and social benefits. The area is comprised of communities with a long history and long-established public and social institutions including places of worship, schools, and community associations.

In 2005 with Hurricane Rita, and again in 2008 with Hurricane Ike, communities in Calcasieu, Cameron, and Vermilion Parishes were inundated by storm surge. In the absence of flood risk reduction measures, local populations were temporarily forced to evacuate and relocate for a significant period, thereby disrupting community cohesion.

1.2.8 Other Social Effects (OSE)

The Hazards and Vulnerability Research Institute at the University of South Carolina created an index that compares the social vulnerability of U.S. counties/parishes to environmental hazards. The variables included in the index are based on previous research which has found that certain characteristics (e.g., poverty, racial/ethnic composition, educational attainment, and proportion over the age of 65) contribute to a community's vulnerability when exposed to hazards. According to the IWR OSE handbook (USACE, 2008), the Social Vulnerability Index (SoVI®) is a valuable tool that can be used in the planning process to identify areas that are socially vulnerable and whose residents may be less able to withstand adverse impacts from hazards.
The SoVI® was computed as a comparative measure of social vulnerability for all counties/parishes in the U.S., with higher scores indicating more social vulnerability than lower scores. Calcasieu Parish has a SoVI® 2006-10 score of -1.21 (0.28 national percentile),

Cameron Parish has a SoVI® 2006-10 score of -3.59 (.08 national percentile), and Vermilion Parish has a SoVI® 2006-10 score of -0.04 (0.49 national percentile). Calcasieu Parish is less socially vulnerable than roughly 28 percent of counties/parishes in the U.S., Cameron Parish is less socially vulnerable than about 8 percent of counties/parishes in the U.S., and Vermilion Parish is less socially vulnerable than roughly 49 percent of counties/parishes in the U.S. In comparison, Orleans Parish—notorious for its enduring levels of high poverty—has a SoVI® 2005-09 score of -0.92 with 67 percent of counties/parishes in the nation ranked more socially vulnerable.

Hence, Cameron Parish is the most socially vulnerable to coastal storm damage consequences, Calcasieu Parish is the next most socially vulnerable, and Vermilion Parish is the least socially vulnerable. In comparison, both Cameron and Calcasieu Parishes are more socially vulnerable to coastal storm damage consequences than Orleans Parish.

1.2.9 Environmental Justice

The EJ study area contains all Census Tracts and Census block groups located within Calcasieu, Cameron, and Vermilion parishes. .

High poverty rates negatively impact the social welfare of residents and undermine the community's ability to provide assistance to residents in times of need. Table 1-7 shows the racial characteristics of the three parishes according to the 2010 U.S. Census. The 2007-2011 American Community Survey (ACS) data indicate that 17 percent of households in Calcasieu Parish, 9 percent in Cameron Parish, and 18 percent in Vermilion Parish fell below the poverty line (figure 1-2). The 2007-2011 Census American Community Survey data indicate that there are:

- 34 poverty areas and 15 extreme poverty areas (block groups) in Calcasieu Parish (all areas are located in the urban center of Lake Charles)
- 0 poverty areas or extreme poverty areas (block groups) in Cameron Parish
- 18 poverty areas and 3 extreme poverty areas (block groups) in Vermilion Parish (all areas are located in Abbeville and Kaplan)

Table 1-7: Racial characteristics in the study area.

Parish	White	African American*	American Indian/Alaska Native*	Asian*	Hawaiian/Pacific Islander*	Total	Percent Minority*
Calcasieu	136,514	47,782	898	2,073	93	192,768	29%
Cameron	6,546	119	36	6	0	6,839	4%
Vermilion	46,922	8,286	209	1,160	5	57,999	20%

* 2010 Census / ** 2007 – 2011 Census

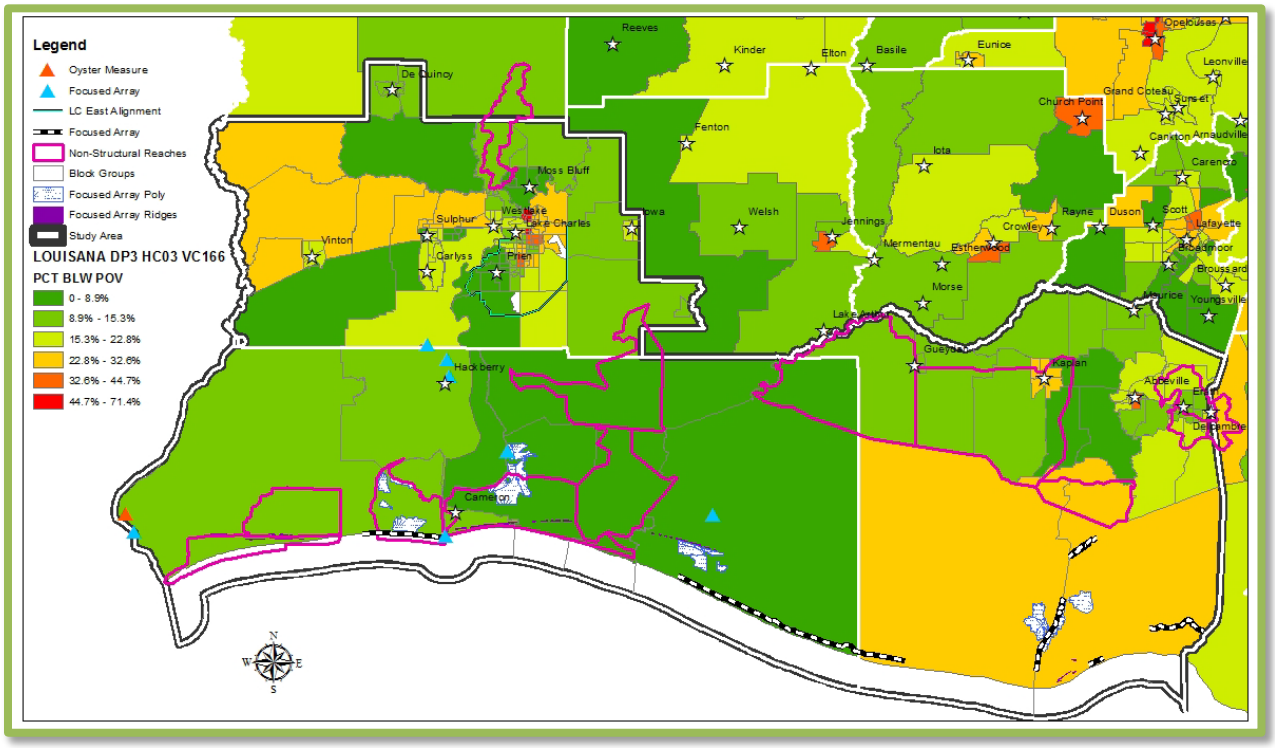


Figure 1-3: Percent population below poverty line by block group.

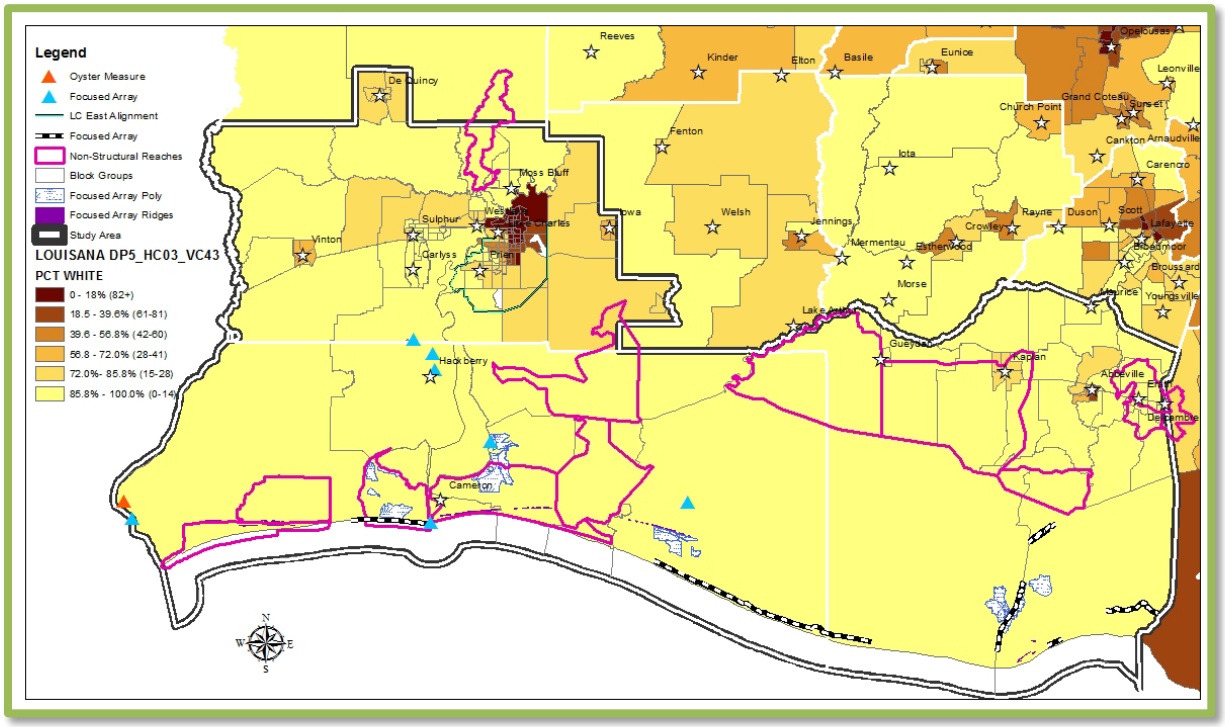


Figure 1-4: Racial majority by block group.

According to the 2010 U.S. Census data, there are 39 block groups in Calcasieu Parish and 9 block groups in Vermilion Parish where 50 percent or more of the population identify themselves

as part of a minority group. There are no block groups in Cameron Parish where more than 1 percent identify themselves as part of a minority group (Figure 1-4).

1.3 Water Environment (Hydrology and Hydraulics)

The two major hydrologic basins in the Chenier Plain are the Mermentau Basin and the Calcasieu-Sabine Basin (LCA, 2004). The Teche-Vermilion Basin is another significant hydrologic basin in the study area. The general location and major features/water bodies in each basin are described below. Figure 1-4 identifies major hydrologic features. For the most part areas below the GIWW are within the coastal zone.

Calcasieu-Sabine Basin - The Calcasieu-Sabine Basin lies in the western portion of the Chenier Plain in Cameron and Calcasieu Parishes. It is bounded to the east by LA Hwy 27, to the south by the Gulf of Mexico, and to the west by the Sabine River and Sabine Lake. The Basin is a shallow coastal wetland system with freshwater input at the north end, a north-south flow through Calcasieu and Sabine lakes, and some east west water movement through the GIWW and interior marsh canals (e.g., North Starks and South Starks canals on the Sabine National Wildlife Refuge). The dominant hydrologic features of the basin are the Calcasieu and Sabine Lakes, which are directly influenced by the Calcasieu, Sabine, and Neches Rivers. Navigation channels include the Sabine-Neches Waterway, Calcasieu River and Pass. Various water control structures in the area include the Calcasieu and Leland Bowman Locks. Managed wetlands are a significant feature of the Calcasieu-Sabine Basin (LADNR 2002).

The Calcasieu drainage basin drainage area north of the point where the river crosses the GIWW is 3,235 square miles. The Sabine drainage basin has a drainage area of 9,760 square miles. The headwaters start in northeastern Texas and the river runs about 150 miles before it meets the Louisiana-Texas state line, then runs to the Gulf. The Toledo Bend Reservoir and Sabine Lake are the major hydrologic features of the Sabine Basin.

The GIWW from the Sabine River to the Calcasieu River is a 125ft wide x 12ft deep. Construction of the GIWW significantly altered regional hydrology by connecting the two major ship channels. Prior to the construction of the GIWW, the Calcasieu and Sabine estuaries were mostly distinct and were more influenced by the Calcasieu and Sabine rivers, respectively. The Gum Cove Ridge once separated the Sabine Basin from the Calcasieu Basin, with little water exchange between the basins. Removing the mouth bars and deepening the CSC and the Sabine-Neches channels, as well as the GIWW and interior canals bisecting the Gum Cove Ridge, made the region hydrologically indistinct, which caused water flow and salinity patterns of one basin to profoundly affect those patterns of the other basin. In addition to effectively combining the two basins, the GIWW cut off all of the natural bayous and upland sheet flow that historically affected marshes, and channelized more freshwater inflow more directly to the Gulf of Mexico, partially bypassing the marshes.

Mermentau Basin - The Mermentau Basin lies in the eastern portion of the Chenier Plain in Cameron and Vermilion Parishes. The Mermentau River Basin can be divided into three sub-basins: Upland, Lakes, and Chenier. The Upland Sub-basin covers an area of 3,683 square miles of predominantly agricultural land. The Lakes Sub-basin is delineated by the Freshwater Bayou Canal on the east, the limit of the coastal zone on the north, Louisiana Highway 27 on the west, and Louisiana Highway 82 on the south. Highway 82 runs atop and between the Grand Chenier-Pecan Island ridge complex. The Chenier Sub-basin lies south of this ridge complex. The dominant hydrologic features of the Mermentau basin are the Grand and White Lakes and the Mermentau River. Navigation channels include the Mermentau Ship Channel.

Various water control structures include the Freshwater Bayou Canal Lock, the Schooner Bayou Canal Structure, and the Catfish Point Control Structure.

Before human-induced hydrologic alterations from navigation channels in the early 1900s, the natural drainage in the Mermentau Basin was dominantly north-south through the Mermentau River, Freshwater Bayou, Bayou Lacassine, and Rollover Bayou. The eastern portion of the basin also drained in an easterly direction through Belle Isle and Schooner bayous. In addition, sheet flow over the marsh occurred between Grand Chenier and Pecan Island ridges, as well as to the west into the Calcasieu/Sabine Basin. Human activities related to wildlife management, navigation improvement, flood control, agriculture, and petrochemical exploitation have dramatically altered the hydrology of the Mermentau Basin. The net effect of these alterations is that drainage through the Lakes Sub-basin is now predominantly east-west and hydrologically isolated from the Chenier Sub-basin. The Lakes Sub-basin now functions more as a freshwater reservoir and less as a low-salinity estuary, its natural form (Gunter and Shell 1958; Morton 1973).

Teche/Vermilion Basin - The Teche/Vermilion Basin extends from Point Chevreuil to Freshwater Bayou Canal and includes East and West Cote Blanche Bays, Vermilion Bay, and the surrounding marshes. Navigation channels include the Freshwater Bayou Canal Navigational Channel. The Basin has a drainage area of 3,040 square miles LCA 2004).

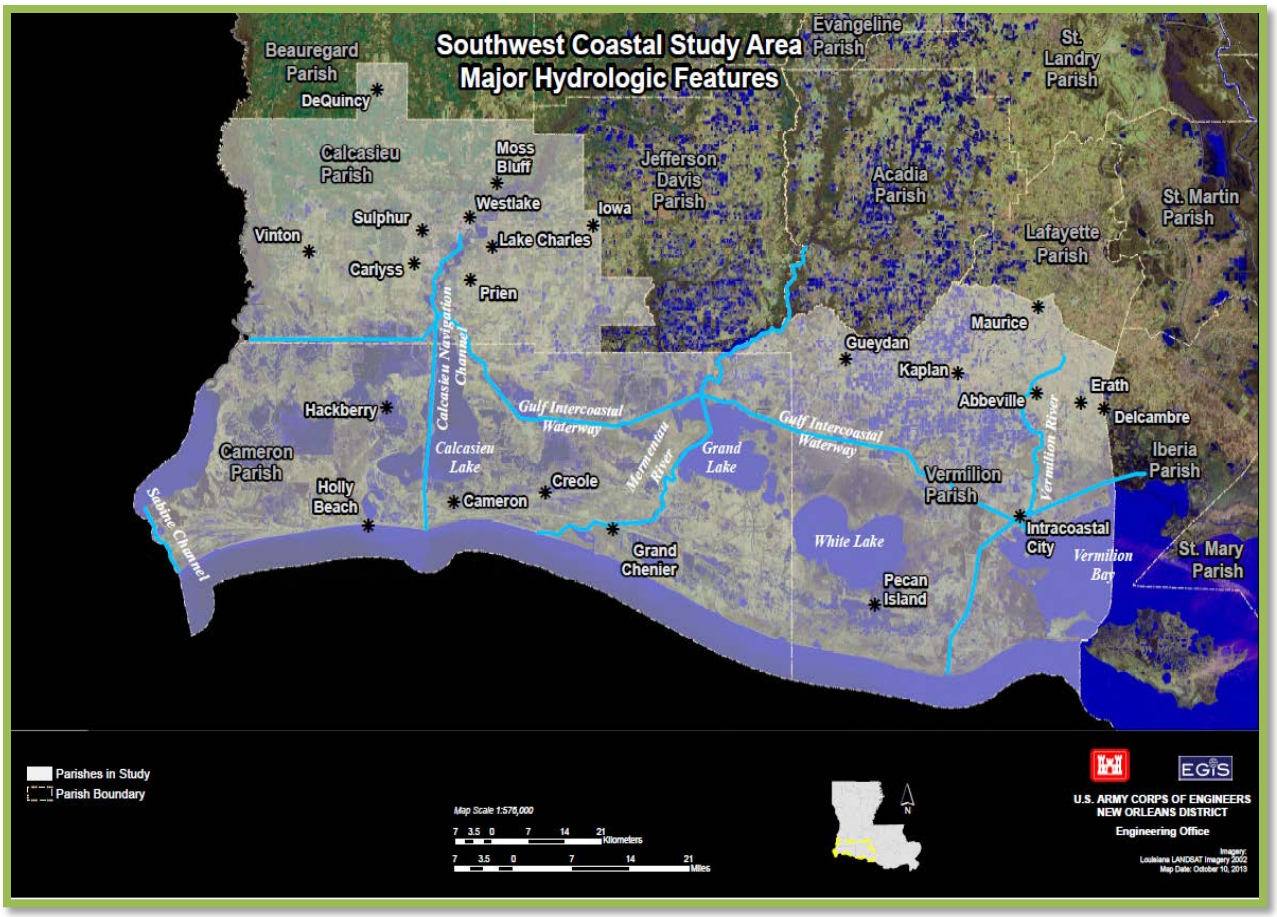


Figure 1-2: Major hydrologic features in the study area.

1.3.1 Water Stage Duration and Frequency

Normal astronomical tides are diurnal (one high tide and one low tide per day) and can have a spring range of as much as 2 feet. The mean tidal range is approximately 1.28 feet at Calcasieu Pass and 1.48 feet at Freshwater Canal. Amplitudes are influenced by tides, but are generally controlled by meteorological events. South winds drive water into the marshes.

1.3.2 Relative Sea Level Rise

In coastal Louisiana, relative sea level rise (RSLR) is the term applied to the difference between the change in eustatic (global) sea level and the change in land elevation. According to IPCC (2007), the global mean sea level rose at an average rate of about 1.7 mm/yr during the 20th Century. Recent climate research has documented global warming during the 20th Century, and has predicted either continued or accelerated global warming for the 21st Century and possibly beyond (IPCC 2007).

Land elevation change can be positive (accreting) or negative (subsiding). Land elevations decrease due to natural causes, such as compaction and consolidation of Holocene deposits and faulting, and human influences such as sub-surface fluid extraction and drainage for agriculture, flood protection, and development. Forced drainage of wetlands results in lowering of the water table resulting in accelerated compaction and oxidation of organic material. Areas under forced drainage can be found throughout coastal Louisiana and the study area. Land elevations increase as a result of sediment accretion (riverine and littoral sources) and organic deposition from vegetation. Vertical accretion in most of the area, however, is insufficient to offset subsidence, causing an overall decrease in land elevations. The combination of subsidence and eustatic sea level rise is likely to cause the landward movement of marine conditions into estuaries, coastal wetlands, and fringing uplands (Day and Templet, 1989; Reid and Trexler 1992).

Subsidence Rates - Subsidence rates vary considerably across coastal Louisiana. A coastwide system for quantifying and predicting subsidence on a regional scale has not yet been established. Therefore, subsidence rates are estimated using a combination of benchmark leveling, tide gauge measurements, and radiometric dating of buried marsh horizons.

The subsidence rate for most of the area is considered low, at zero to 1 ft/century; however, the subsidence rates in the Mermentau Basin for Hackberry Ridge, Big Lake, Cameron-Creole, Brown Lake, Hog Island Gully, and Mud Lake watersheds are considered intermediate, at 1.1 – 2 ft per century. Perry Ridge in the Calcasieu/Sabine Basin and Locust Island and Little Prairie in the Mermentau Basin are considered stable (Coast 2050, 2009).

Accretion Rates - Net accretion varies significantly on a local level and over time. Average measurements of accretion across the Louisiana coastal region indicate that current accretion rates are 0.7 to 0.8 cm per year (ERDC/EL TN-10-5). Since there is currently a lack of evidence to support applying a habitat specific accretion rate, a long-term accretion estimate of 0.7 cm per year captures the central tendency of all herbaceous marsh data that have been reviewed for the SW Coastal LA analysis.

1.3.3 Storm Surge

While the study area has periodically experienced localized flooding from excessive rainfall events, the primary cause of the flooding events has been the tidal surges from hurricanes and tropical storms. During the past eight years, the area has been greatly impacted by storm surges associated with three Category 2 or higher hurricanes—Lili, Rita, and Ike, which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane surge also causes significant damage to wetlands. Hurricane surge has

formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

1.3.4 Storms of Record

October 2002. Hurricane Lili was originally a Category 4 hurricane and first made landfall as a downgraded Category 2 hurricane near Intracoastal City, LA to the west. Wind gusts up to 61 mph were reported. Rainfall estimates were rather low at 5 inches, due to the rapid forward movement of the storm. Tide levels were 4 to 7 feet above normal, with many areas outside of the study area being flooded. The stage at Harvey Canal at Lapalco reached 9.84 feet NGVD on the 5th.

September 2005. Hurricane Rita first made landfall just west of Johnson's Bayou, LA as a Category 3 hurricane after downgrading from a 180 mph Category 5 hurricane. The coastal communities of southwest Louisiana were all heavily damaged or totally destroyed by the 20-foot surge. The storm surge also completely overtopped the Calcasieu Lock structure. Many low lying areas in Lake Charles flooded.

September 2008. Hurricane Ike first made landfall near Galveston, Texas as a Category 2 hurricane with 110 mph winds on September 13, 2008. Although landfall was to the west in Texas, this storm caused extensive flooding due to storm surge created by the large wind field along the south central and southwest coastal parishes of Louisiana. The storm surge also completely overtopped the Calcasieu Lock structure.

1.3.5 Flow and Water Levels

The marsh area of southwest Louisiana extends northward and slightly beyond the GIWW. Rainfall runoff drains from the higher elevations in the north and is trapped in the marsh area to the south due to Chenier ridges that parallel the coast. The natural drainage pattern prior to the construction of the GIWW was for rainfall in the basin to drain through the Mermentau River and empty into the Gulf of Mexico. However, some of that flow is now redistributed to the east and west along the GIWW. The Calcasieu Lock, Catfish Point Control Structure, Leland Bowman Lock, and Schooner Bayou Lock were created to allow for navigation and salinity control.

Land stewardship through hydrologic management and shoreline protection are the mainstays of coastal restoration in the Calcasieu-Sabine basin. Water control structures are operated both passively and actively. Virtually all hydrologic management focuses on controlling salinity and minimizing tidal fluctuations by constructing and operating levees, weirs, and a variety of gated structures. A 1990 inventory of such water control structures identified 174 individual structures in the interior and along the perimeter of the basin (LADNR 2002; Marcantel 1996).

The Cameron-Creole Watershed Project covers approximately 176 square miles in Cameron Parish. The area is bounded by the GIWW on the north; Calcasieu Lake and Calcasieu Pass on the west; LA Highway 27, Little Chenier Ridge, and Creole Canal on the east; and the Gulf of Mexico and Mermentau River on the south. To counter this conversion of marsh to open water, the Cameron-Creole Watershed Project was initiated cooperatively by the Soil Conservation Service (now NRCS), Gulf Coast Soil and Water Conservation District, Cameron Parish Police Jury, Cameron Parish Gravity Drainage Districts 3 and 4, the Miami Corporation, and the USFWS, Sabine National Wildlife Refuge. The water control structures began operation in 1989 (LADNR 2002).

1.3.6 Water Quality and Salinity

Water quality is influenced by Chenier Plain elevations and geomorphologic processes, surface water budget, land cover and use, and regional weather. The study area consists of low relief topography to the north and estuary to the south, with increasing estuary salinity gradients to the south. The Calcasieu River is connected to the Gulf of Mexico via the Calcasieu ship channel (CSC) and the Mermentau River basin is maintained as a freshwater environment via several water control structures (Rosen and Xu 2011). Hydromodification has occurred as a result of the construction of water control structures, canals, and embankments (Demcheck et al. 2004).

The Sabine River is the dominant influence across most of the basin in moderating gulf salinity and tidal fluctuations. Observations by USFWS personnel reveal that strong and prolonged south and southeast winds result in large volumes of Gulf of Mexico water being pushed into Calcasieu and Sabine lakes, which causes the water level in the marshes to rise (Paille 1996). A similar effect on marsh water level has been observed during periods of low barometric pressure in the region (LADNR 2002; Paille 1996).

The primary saltwater barrier in the Calcasieu Basin is the Calcasieu Lock, located approximately two miles east of the CSC. This sector-gated lock, which opened in 1950, was designed to prevent saltwater intrusion into the Mermentau Basin, and is operated primarily for navigation. During flooding events, the structure is often operated for drainage of the Mermentau Basin to the east.

In general, water quality concerns are related to urbanization to the north, oil and gas activities and saltwater intrusion in the Calcasieu River basin, and agriculture in the Mermentau River basin. Reference the following literature for water quality and salinity studies in the area: Demcheck et al. (2004), Garrison (1997), Waldon (1996), Skrobialowski et al. (2004), Demcheck and Skrobialowski (2003), Macdonald et al. (2011), Rosen and Xu (2011), and Steyer et al. (2008).

Historically (1998-2012) Clean Water Act Section 305(b) assessments of subsegments in the area were evaluated. Long-term average support values reveal that impairments are most common in the uppermost subsegments in the Calcasieu and Teche-Vermillion watersheds. The most commonly suspected causes of impairments were low dissolved oxygen, elevated total suspended solids, mercury, elevated turbidity, nitrate/nitrite, carbofuran, and total phosphorus, while the most commonly suspected sources were unknown, agriculture, natural, atmospheric deposition, flow alteration, urban runoff, and on-site treatment systems. In a recent 305(b) assessment (2012), the most frequently cited suspected causes of impairment included fecal coliform, low dissolved oxygen, turbidity, mercury, total suspended solids, and carbofuran, while most frequently cited suspected sources of impairment include unknown, agriculture, natural, on-site treatment systems, atmospheric deposition, and drought-related effects (LDEQ 2013). Information and analysis for water quality monitoring will be developed for the TSP following sampling, analysis, and evaluation of water quality and sediment for the project conducted in later project phases.

1.4 Natural Environment

1.4.1 Sedimentation and Erosion

The study area is divided by the Sabine, Calcasieu, Mermentau, and Vermilion rivers which flow in a north-south direction. These rivers have been highly altered by the placement of locks and dams, dredged channels, manmade outlets to the Gulf, and bisected by the GIWW. These alterations influence the movement of sediment throughout the area. The rivers and interior lakes which they enter (Sabine, Calcasieu, and Grand) act as sediment sinks. Overbank

deposition into adjacent marshes is minimal in these low flow rivers. Sediments in the interior lakes can be resuspended and deposited in adjacent marshes during storm events and cold front passages. Extensive hydrologic alterations within the area (levees, channels, roads, locks, control structures, etc.) influence sediment movement throughout. Sediments in the rivers that make it to the coast are deposited at the mouths and generally move westward nourishing the beaches and marshes.

A significant source of sediment is the Atchafalaya River. Sediment travels westward from Atchafalaya Bay and the GIWW and enters the area through tidal exchange at the Gulf and from flooding during storm events. A large percentage of Atchafalaya River sediments are deposited along the Gulf shoreline in the vicinity of Freshwater Bayou as mudflats while coarser sediments continue westward along the shoreline.

Erosion of material by wave and current action is found throughout. The shorelines of most channels, lakes, and the Gulf are experiencing erosion. Erosion rates are generally highest where the shorelines protrude into the lakes, focusing wave and current action. The Louisiana coast has approximately 350 miles of sandy shoreline along its barrier islands and gulf beaches; however, there are about 30,000 miles of land-water interface along bays, lakes, canals, and streams. Most of these consist of muddy shorelines and bank lines, and virtually all are eroding. In many instances, rims of firmer soil around lakes and bays, and natural levees along streams have eroded away leaving highly organic marsh soils directly exposed to open water wave attack. Examples include Redfish Point, Grassy Point, Umbrella Point, Short Point, and Commissary Point. High rates of Gulf shoreline erosion occur from the vicinity of Rollover Bayou, west to Mermentau River. Accelerated shoreline loss occurs where erosion has caused Gulf, lake, and channel shorelines to intersect interior water bodies.

1.4.2 Soils, Water Bottoms and Prime and Unique Farmlands

Both hydric and non-hydric soils are found through. The area consists generally of forested terrace uplands and Gulf Coast Prairies in the northern portions and Gulf Coast Marsh habitats in the southernmost portions. Predominate soils are described in appendix A. The major water bottoms throughout include: Lake Charles, Prien Lake, Sabine Lake, Calcasieu Lake, Grand Lake, White Lake and Vermilion Bay. There are numerous smaller lakes such as Sweet Lake, Mud Lake, Black Lake, Big Constance Lake, and Lake Misere. Rivers include the Calcasieu, Sabine, Mermentau and Vermillion Rivers. A listing of the water bottoms is described in appendix A

Prime and Unique Farmlands: Prime farmlands are present and make up approximately 941,196 acres, or 34.3 percent of the soils; breakdown by parish is as follows: Calcasieu Parish is 479,426 acres, or 68.5 percent; Cameron Parish is 106,008 acres, or 10 percent; Vermilion Parish is 355,761 acres, or 36 percent. The majority of the Gulf Coast Marshes consists of wetland type soils and shorelines that are prone to frequent flooding and not suitable for agricultural use. Prime farmland is more predominant inland, and outside, of the Gulf Coast Marsh physiographic area. Prime farmland can also be found on natural ridge tops and cheniers (Hackberry loamy fine sand).

Prime farmland soils are best suited for producing food, feed, forage, fiber, and oilseed crops, and posses qualities that are favorable for crop production using only acceptable farming methods (NRCS Soil Survey of Calcasieu Parish, dated June 1988). Several soil types exist that meet those qualities and are identified as prime farmlands. These are listed in appendix A. Urban areas, like Lake Charles and Abbeville, as well as industrial areas have excluded some

prime farmlands from agricultural use. There is no Unique farmland. Coordination with the Natural Resources Conservation Service (NRCS) is on-going.

1.4.3 Gulf Coastal Shorelines

Gulf coastal shorelines, located along the northern rim of the Gulf of Mexico, provide essential and critical shelter, nesting, feeding, roosting, cover, nursery, and other habits and life requirements for fish and wildlife. They function as the boundary between marine and estuarine ecosystems and provide protection to the estuarine wetlands, bays, and other inland habitats.

Coastal shorelines, as well as other coastal landscape features such as shoals, coastal marshes, and forested wetlands, can provide a significant and potentially sustainable buffer from wind wave action and storm surge generated by tropical storms and hurricanes. Rapid deterioration of the barrier coast is resulting in a transformation of low-energy, semi-protected bays into high-energy, open marine environments (Stone et al. 2005). Numerical modeling by Stone et al. (2005) demonstrated that physical loss of the barrier system and marsh results in a considerable increase in modeled storm surge levels and wave heights. Geomorphic features such as coastal shorelines and barrier islands, as well as coastal marsh and other wetland land masses can block or channelize flows (Working Group for Post-Hurricane Planning for the Louisiana Coast 2006). The area's coastal shorelines are experiencing some of the highest land loss rates in the Nation, due to both natural and man-made factors (USACE 2004).

Barrier beach and surf, dune, supratidal and intertidal wetlands and swale habitats have undergone substantial loss due to oil and gas activities (e.g., pipeline construction), construction of navigation channels and jetties, subsidence, sea-level rise, and marine and wind-induced erosion. Recent estimates find Gulf shoreline recession rates vary from 8 feet per year near Cheniere Au Tigre to 52.9 feet per year near the center of the 76,000-acre Rockefeller Wildlife Refuge, located in eastern Cameron and western Vermilion Parishes which borders the Gulf of Mexico for 26.5 miles.

1.4.4 Vegetation Resources

The area consists of open water ponds and lakes, cheniers, Gulf shorelines, and freshwater, intermediate, brackish, and saline marsh. Table 1-9 compares habitat types pre- and post-Hurricane Rita.

Gulf Coast Prairie and Forested Terraced Uplands vegetation includes:

- Swamp, found in low-lying areas typically adjacent to waterways, is dominated by cypress and tupelo-gum.
- Riverine habitats along stream and river bottoms and bottomland forests are comprised of water tupelo, willow, sycamore, cottonwoods, green ash, pecan, elm, cherrybark oak, white oak; these are often interspersed with Chinese tallow. Depending upon the locations, riverine habitats grade into higher elevated and better drained areas comprised of oak-pine forests.
- Oak-pine forest types dominate the better drained areas especially surrounding Lake Charles and Sulfur and include longleaf pine, loblolly pine, slash pine, sweetgum, blackgum, elm, southern red oak, water oak, black gum and Chinese tallow.
- Pasture and rangelands with mixtures of perennial grasses and legumes (e.g., bermundagrass, Pensacola bahiagras, tall fescue, and white clover) comprise the majority of the outlying areas surrounding Abbeville, Erath and Delcombre.

The Gulf Coast Marsh consists of gulf shorelines with barrier shorelines, dunes and back barrier vegetated areas; cheniers; freshwater, intermediate, brackish, and saline marsh; interspersed

with bayous, lakes, ponds and other waters of which some may include subaquatic vegetation (SAVs). Vegetation typically follows the salinity gradient (O'Neil 1949; Chabreck et al. 1972; Gosselink et al. 1979; Visser et al. (2000):

- Gulf shorelines vegetation includes sea-beach orach, sea rocket, pigweed, beach tea, salt grass, seaside heliotrope, common and sea purslane, marsh-hay cordgrass, and coastal dropsead (LCA 2004, Gosselink et al. 1979).
- Cheniers are live oak-hackberry forests with live oak and hackberry the dominant tree canopy species with other typical species including swamp red maple, toothache tree, green ash, American elm. Although this forest type is the typical habitat, some areas may be scrub thicket or grasslands (source: http://dnr.louisiana.gov/assets/docs/coastal/227-009-001NG-Chenier-Rpt-DNR.pdf; accessed September 16, 2013; LADNR 2009).
- Marsh types: Visser et al (2000), expanding on previous studies by Penfound and Hathaway (1938) and Chabreck (1970), classified freshwater marsh in the Chenier Plain as a combination of maidencane and bulltongue arrowhead; intermediate marsh as sawgrass, saltmeadow cordgrass, and California bulrush; brackish marsh as saltmeadow cordgrass, chairmaker's bulrush, and sturdy bulrush; and saline marsh as smooth cordgrass, needlegrass rush, and saltgrass.
- SAVs: wild celery, duckweed, pickerelweed, sago pondweed, southern naiad.

Table 1-8: Habitat types by basin in acres. Square kilometers (km^2) listed in parentheses.

Habitat Type	Calcasieu/Sabine Basin		Mermentau Basin		Teche/Vermilion Basin	
	2004	2005	2004	2005	2004	2005
Forested Wetlands	0.00 (0)	0.00 (0)	0.00 (0)	0.00 (0)	46,080 (186.5)	46,080 (186.5)
Other Land	46,080 (186.5)	45,4400 (183.9)	51,840 (209.8)	38,400 (155.4)	21,760 (88.1)	20,480 (82.9)
Freshwater Marsh	96,000 (388.5)	89,600 (362.6)	281,601 (1,139.6)	230,401 (932.4)	33,280 (134.68)	32,640 (132.1)
Intermediate Marsh	177,520 (694.1)	163,200 (660.5)	119,680 (484.3)	103,040 (417.0)	122,880 (497.3)	122,600 (492.1)
Brackish Marsh	81,280 (328.9)	78,720 (318.6)	60,800 (246.1)	55,680 (225.3)	82,560 (334.1)	80,640 (326.3)
Saline Marsh	8,960 (36.3)	8,960 (36.3)	26,240 (106.3)	25,600 (103.6)	5,120 (20.7)	5,120 (20.7)
Water	184,961 (748.5)	202,881 (821.0)	202,241 (818.4)	289,281 (1,170.7)	348,162 (1,408.9)	353,281 (1,429.7)
Totals	588,803 (2,382.8)	588,803 (2,382.8)	742,403 (3,004.4)	742,403 (3,004.4)	659,843 (2,670.3)	659,843 (2,670.3)

Land Loss – The process for wetland loss can start with the result of gradual decline of marsh vegetation due to inundation and saltwater intrusion eventually leading to complete loss of marsh vegetation or the result of storm surge events. As marsh vegetation is lost, underlying soils are more susceptible to erosion and are typically lost as well, leading to deeper water and precluding marsh regeneration. Significant accretion of sediments is then required in order for marsh habitat to reestablish. Perhaps the most serious and complex problem in the study area is the rate of land and habitat loss. The Louisiana coastal plain contains one of the largest expanses of coastal wetlands in the contiguous United States and accounts for 90 percent of the total coastal marsh loss in the nation (USACE 2004).

The effects of recent hurricanes have accelerated marsh loss. Table 1-10 includes estimates of wetland loss attributed to the major hurricanes of 2004 to 2008 in the Chenier Plain and throughout coastal Louisiana.

Table 1-9: Wetland loss estimates (km^2) following hurricanes Katrina and Rita (2005) and Gustav and Ike (2008) by geographic province (Barras 2009).

Period	Storms	Chenier Plain	Marginal Delta Plain	Delta Plain	Coastal Louisiana
2004-2006	Katrina + Rita	-292	-2.6	-230	-525
2006-2008	Gustav + Ike	-139	-59	-124	-323
2004-2008	All storms	-432	-62	-354	-848

1.4.5 Rare, Unique, and Imperiled Vegetative Communities

The following rare, unique, and imperiled communities, documented by the Louisiana Natural Heritage Program, are important in that they contribute to the diversity and stability of the coastal ecosystem. Table 1-11 displays information from the LNHP database identifying rare, unique or imperiled vegetative communities (LDWF 2013).

Table 1-10: LNHP rare, unique, or imperiled vegetative communities.

Vegetative Communities	Basins or Parish
Submergent Vascular Vegetation (Marine & Estuarine)	Waters of northern Gulf of Mexico, Vermilion-Teche, Mermentau, Calcasieu and Sabine.
Salt Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Brackish Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Intermediate Marsh	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Coastal Prairie	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Flatwoods Ponds	Calcasieu Parish
Western Hillside Seepage Bogs	Calcasieu and Sabine
Scrub/Shrub Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Cypress Swamp	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Bottomland Hardwood Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Bature	Vermilion-Teche
Live Oak Natural Levee Forest	Vermilion-Teche
Bayhead Swamp/Forested Seep	Calcasieu Parish
Pine Flatwoods	Calcasieu Parish
Western Longleaf Pine Savannah	Calcasieu Parish
Small Stream Forest	Calcasieu Parish
Coastal Dune Grassland	Mermentau, Calcasieu, Sabine
Coastal Dune Shrub Thicket	Mermentau, Cacasieu, Sabine
Coastal Live Oak-Hackberry Forest	Vermilion-Teche, Mermentau, Calcasieu and Sabine
Western Upland Longleaf Pine Forest	Calcasieu Parish
Western Xeric Sandhill Woodland	Calcasieu Parish
(source: http://www.wlf.louisiana.gov/wildlife/louisiana-natural-heritage-program)	

1.4.6 Wildlife Resources

Coastal and especially estuarine wildlife is taxonomically diverse with distributions shaped by landforms, climate, salinity, tides, vegetation, other animals and human activities (Day et al. 1989). Appendix A shows the status, functions of interest, trends, and projections from 1985 through 2050 for avifauna, furbearers, game mammals, and reptiles as adapted from the Coast 2050 report by LCWCRTF & WCRA (1999).

Area estuarine wetlands, cheniers and barrier habitats have historically provided many different species of birds and other wildlife with shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. These habitats provide neotropical migrants with essential staging and stopover habitat (after Stoffer and Zoller 2004, Zoller 2004). Cheniers attract thousands of trans-Gulf migrant birds during their peak migratory months of April to May and August through October. The majority of these birds fly to and from parts of Mexico, and the cheniers offer the birds an important stop-over on their migration. Millions of ducks and geese use the area from September through February. Over 300 species of birds have been recorded in the area, making this region a popular destination for visiting birders, wildlife photographers, and hunters. However, climate and seasonal availability of resources affect the ways estuaries are used by birds and other wildlife (Day et al. 1989). Vegetated habitats within urban and suburban areas, such as bottomland hardwood (BLH) and swamp habitats along streams, lakes and other waterways, provide critical breeding bird habitats (Wakeley and Roberts 1996).

Among the several sources documenting Louisiana birds, Lowery (1974) and the US Forest Service (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed September 20, 2013) indicate the area supports shorebirds (e.g., piping plover, sandpipers, gulls, stilts, skimmers and oystercatchers), ducks and geese (e.g., mottled duck, mallard, fulvous tree-duck, pintail, teal, wood duck, scaup, mergansers and Canada goose); herons, egrets, ibis and commorants; hawks and owls (e.g., bald eagle, osprey and barred owl); belted kingfisher; woodpeckers and sapsuckers; marsh birds (e.g., rails and gallinules); and various songbirds (e.g., wrens, flycatchers, swallows, warblers, and vireos). Waterfowl, seabirds, coots, and rails populations are stable within the Calcasieu-Sabine and Mermentau basins (Appendix A (LCWCRTF & WCRA 1999)).

The bald eagle and brown pelican have increased in populations resulting in de-listing as endangered species. Colonial nesting waterbird rookeries (e.g., herons, egrets, ibis, night-herons, and roseate spoonbills) are found throughout and generally show stable or increasing populations (Appendix A (LCWCRTF & WCRA 1999)).

Habitat loss and fragmentation is among the most pervasive threats to the conservation of biological diversity (Rosenberg et al. 1997). Area BLH, swamp and other riverine habitats provide travel corridors for birds and other wildlife connecting populations which have been effected by habitat loss and fragmentation. The greatest threat to birds throughout not only the area, but the entire North American continent, is habitat loss (American Bird Conservancy 2009).

Most estuarine mammals show distributions or behaviors that are related to salinity patterns (Day et al. 1989). Large herbivores and carnivores include manatee, coyote, red wolf, ringtail, and river otter; smaller herbivores include swamp rabbit, fulvous harvest mouse, eastern wood rat, and nutria (source: http://www.fs.fed.us/land/pubs/ecoregions/ch21.html accessed September 20, 2013). Populations of furbearers (nutria, muskrat, mink, otter, and raccoon) and game mammals (rabbits, squirrels, and white-tailed deer) have been stable or increasing (Appendix A (LCWCRTF & WCRA 1999)).

Prior to the introduction of nutria to Louisiana in 1930s (USGS 2000, Baroch et al. 2002), no invasive wildlife species were known to be present. Areas of extensive nutria damage, or “eat outs,” alter the composition and habitat type of wetland communities (USGS, 2000). Aerial surveys estimated 80,000 acres of marsh in the State of Louisiana were damaged by nutria (Keddy et al. 2007).

A listing of the common species of amphibians and reptiles can be found in appendix A. Little is known about amphibian or reptile populations with the exception of the American alligator. Since 1972, over 700,000 wild alligators have been harvested, over 5.2 million alligator eggs have been collected, and over 2.7 million farm raised alligators have been sold, bringing in an estimated $495,000,000 to the state of Louisiana (Louisiana Department of Wildlife and Fisheries [LDWF], 2006). According to LDWF scientists, the alligator population dropped significantly between 2008 and 2009. In 2008, more than 43,000 alligator nests were found, while in 2009 only 24,500 nests were found, a 43 percent statewide decrease. This drop in alligator nests is probably the result of saltwater intrusion during Hurricanes Gustav and Ike. A similar trend occurred after Hurricanes Katrina and Rita, with alligator nests decreasing between the 2005 and 2006 surveys. However, the number of nests found increased significantly by 2007.

1.4.7 Aquatic and Fisheries Resources

Plankton communities serve several important roles in coastal waters. Bacterioplankton are primarily decomposers; phytoplankton are the primary producers of the water column, and form the base of the estuarine food web; zooplankton provide the trophic link between the phytoplankton and the intermediate level consumers such as aquatic invertebrates, larval fish, and smaller forage fish species (Day et al. 1989; Thompson and Forman 1987). Biological factors such as predation by nekton and ctenophores, duration of the larval stages of meroplankton, and changes in the aquatic environment brought by the zooplankton populations themselves are important biological factors in the regulation of zooplankton densities (Bouchard and Turner 1976; Conner and Day 1987). Bouchard and Turner (1976) found that salinity largely influenced the distribution of zooplankton. Gillespie (1978) found spring zooplankton peaks were related to temperature. Conner and Day (1987) identified the following factors affecting zooplankton populations: tidal flushing, inflow of freshwater carrying organic detritus, river discharge, water depth, tidal changes, turbidity, and dissolved oxygen.

Gosselink et al. (1979) provide an extensive overview of benthic resources in the area. The bottom estuarine substrate or benthic zone regulates or modifies most physical, chemical, geological, and biological processes throughout the entire estuarine system via what is called a benthic effect (Day et al. 1989). Benthic communities do not have a static structure; rather, they provide a residence for many sessile, burrowing, crawling, and even swimming organisms.

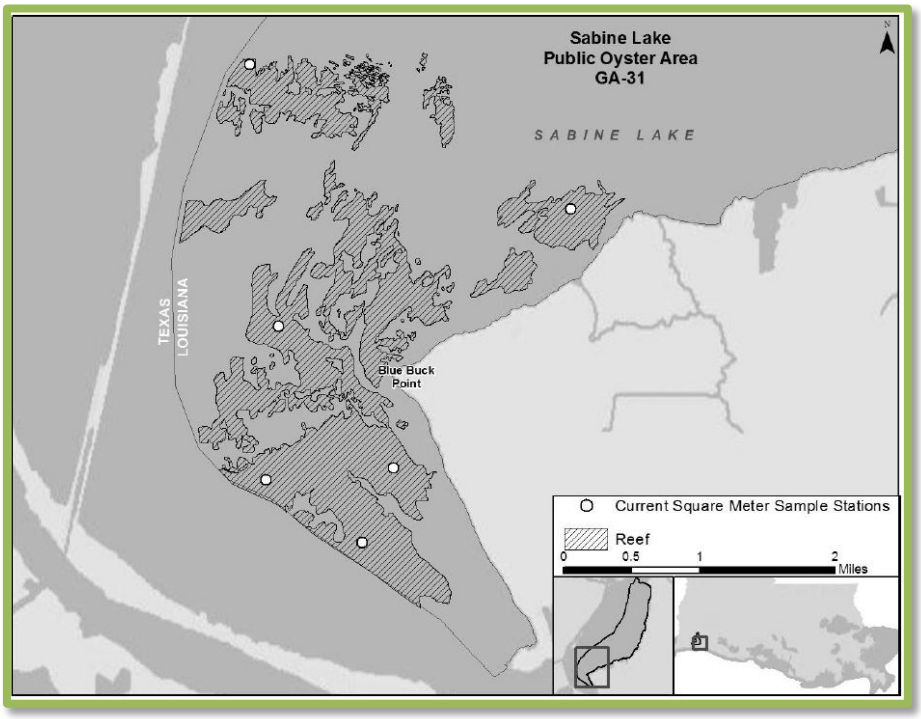


Figure 1-5: Oyster reefs in Sabine Lake.

Benthic animals are directly or indirectly involved in most physical and chemical processes that occur in estuaries and trophic relationships that occur in aquatic ecosystems (Day et al. 1989). Oysters and mussels from the epibenthic community provide commercial and recreational fisheries and create oyster reef habitats used by many marine and estuarine organisms. A discussion on estuarine benthic organisms and primary consumer groups is in appendix A. A major link in the aquatic food web between plants and predators is formed by the conversion of plant material (formed in primary production) by benthic detritivores and herbivores to animal tissue (Cole 1975). The salt marsh is a major producer of detritus for both the salt marsh system and the adjacent estuary (Mitsch and Gosselink 2000). In some cases, exported marsh detritus is more important than the phytoplankton based production to the estuary. Detritus export and the shelter found along marsh edges make salt marshes important nursery areas for many commercially important fish and shellfish.

The American oyster is a keystone estuarine species and has been identified as an ecosystem engineer (Dame 1996). Oyster reefs provide major structural components of estuaries and support more animal life than any other portion of the sea bottom (Bahr and Lanier 1981; Meyer and Townsend 2000; Nelson et al. 2004; Tolley and Volety 2005; Tolley et al. 2005; Boudreaux et al. 2006). The total number and densities of fish, invertebrate and algal species greatly increase in areas containing oyster reefs (Bahr & Lanier 1981). More than 300 marine invertebrate species may occupy an oyster reef at one time (Wells 1961). In addition to increasing species richness, the three-dimensional structure of the reef provides other services such as stabilizing and buffering shorelines from high wave energy (Smithsonian 2001). Because oysters are sessile and pump water through their bodies, they are recognized as good ecosystem monitors. Changes in ecosystem health can be noted over time scales varying from hours to years. Because oysters are continually submersed in environmental conditions, they actively contribute to water quality assessments (Smithsonian 2001). In addition, the chemistry of their shell can provide information on global changes in the environment (Surge et al. 2003). Accordingly, oysters have been used as monitors and indicators of stress in marine ecosystems. Figure 1-5 shows the location of the oyster reefs Sabine Lake. Calcasieu Lake has been designated by the LDWF as a Public Oyster Tonging Area. More information on oysters including locations of oyster reefs in other areas can be found at the Louisiana Department of Wildlife and fisheries website (http://www.wlf.louisiana.gov/fishing/oyster-program). The Louisiana portion of Sabine Lake has approximately 34,067 water bottom acres. This area was cleared by LDHH in March of 2011 for harvesting, but LDWF has not opened a season on this area at this time.

Salinity and submerged vegetation affect the distribution of fish and macrocrustaceans throughout the area with three general types: freshwater, resident, and transient marine species. Freshwater species, some of which may tolerate low salinities, generally live in the freshwater portions of the more interior and northern-most regions of the area. Resident species are generally smaller and do not commonly migrate very far.

Marine transient species spend a portion of their life cycle in the estuary, generally spawning offshore or in high-salinity bays, and use coastal marshes as nursery areas (Herke 1971, 1995). A description of species typically found in freshwater areas is included in appendix A.

1.4.8 Essential Fish Habitat (EFH)

Figures displaying EFH for coastal migratory pelagics (king mackerel, Spanish mackerel and cobia); shrimp (brown, white and pink shrimp); red drum; and stone crab, respectively within the area is provided in appendix A. Table 1-12 list the EFH for life stages of species

Table 1-11: EFH for life stages of EFH species.

Species	Life Stage	EFH
Brown shrimp	eggs	Gulf of Mexico < 110 m, demersal
	larvae	Gulf of Mexico < 110 m, planktonic
	postlarvae/ juvenile	marsh edge, SAV, tidal creeks, inner marsh
	subadult	estuarine mud bottoms, marsh edge
	adult	Gulf of Mexico <110m, silt sand, muddy sand
White shrimp	eggs	Gulf of Mexico < 40 m, demersal
	larvae	Gulf of Mexico < 40 m, planktonic
	postlarvae/ juvenile,	marsh edge, SAV, marsh ponds, inner marsh, oyster reefs
	subadult	marsh edge, SAV, marsh ponds, inner marsh, oyster reefs
	adult	Gulf of Mexico < 33 m, silt, soft mud
Red drum	eggs, larvae	Gulf of Mexico planktonic
	postlarvae/juvenile	SAV, estuarine mud bottoms, marsh/water interface
	subadult	estuarine mud bottoms, oyster reefs
	adult	(Marine and Estuarine systems) Gulf of Mexico & estuarine mud bottoms, oyster reefs
Spanish mackerel	larvae	offshore <50 m
	juvenile	offshore, beach, estuarine
	adult	marine pelagic
King Mackerel Cobia	juvenile/adults	marine pelagic
	eggs	marine pelagic
	larvae	estuarine & shelf
	postlarvae/juvenile	coastal & shelf
	adults	coastal & shelf
	(source: http://www.habitat.noaa.gov/protection/efh/newInv/index.html)	

1.4.8.1 Threatened/Endangered Species and Other Protected or Species of Concern

There are eleven threatened or endangered species (T&E), one candidate species known or believed to occur in the area (see table 1-13) as well as critical wintering habitat for the piping plover. There are no threatened or endangered plants (personal communication with USFWS, September 20, 2013). A detailed description of T&E species and critical habitats is presented in appendix A.

Table 1-12: EFH for life stages of EFH species.

Species	Acadia Parish	Calcasieu Parish	Cameron Parish	Vermilion Parish
*Sprague's Pipit (*Anthus spragueii*)	Candidate	Candidate	Candidate	Candidate
Red-cockaded woodpecker (*Picoides borealis*)		Endangered		
Piping plover (*Charadrius melodus*)			Threatened Critical habitat	Threatened Critical habitat
*Red knot (*Calidris canutus*)			Threatened	Threatened
**Whooping crane (*Grus americana*)				Threatened
West Indian manatee (*Trichechus manatus*)			Endangered	Endangered

Species	Acadia Parish	Calcasieu Parish	Cameron Parish	Vermilion Parish
Gulf sturgeon (*Acipenser oxyrinchus desotoi*)			Threatened	Threatened
Green sea turtle (*Chelonia mydas*)			Threatened	Threatened
Kemp's (Atlantic) ridley sea turtle (*Lepidochelys kempi*)			Endangered	Endangered
Leatherback sea turtle (*Dermochelys coriacea*)			Endangered	Endangered
Loggerhead sea turtle (*Caretta caretta*)			Endangered	Endangered
* Candidate species are those taxa for which the Service has on file sufficient information regarding biological vulnerability and threat(s) to support issuance of a proposal to list. **This is a nonessential population which is considered "threatened." However, Section 7 of the Endangered Species Act consultation regulations do not apply.				

Piping plovers winter in Louisiana but do not nest on the coast. Critical wintering habitat encompasses 24,950 acres along 342.5 miles of shoreline, which is most of the coast of Louisiana. Piping plovers arrive from their northern breeding grounds as early as late July and may be present on designated critical wintering habitat for 8 to 10 months of the year.

1.4.8.2 Historic and Cultural Resources

The cultural history of coastal southwest Louisiana is a very rich one, going back some 10,000 years or more. The general chronological sequence of Louisiana's past can be summarized as follows: Paleoindian (11,500 - 8,000 B.C.), Archaic (8,000 - 800 B.C.), Woodland (800 B.C. - A.D. 1200), and Mississippian (A.D.1200 - 1700). The historic period begins at approximately A.D. 1700, and historic perspectives include the Attakapa Indians, first European settlement in Attakapa country, the Acadian migration, the Louisiana Purchase with the western boundary of the United States in dispute until 1819, the Civil War, postbellum period, and the early 20th century.

The NED alternatives are located within both the Marginal Plain and the Pleistocene Prairie Terrace, while the NER alternatives are limited to the Marginal Plain. Archaeological sites in the southernmost portion of the area postdate the formation of the Marginal Plain (or Chenier Plain) at the end of the Pleistocene Epoch.

Numerous archaeological sites have been previously recorded within a one-mile buffer of the NED alternative. Thousands of standing structures that have been identified as potential candidates for nonstructural measures have a minimum age of 50 years and have not been assessed for eligibility. Fourteen historic properties have been identified in Calcasieu Parish, including ten that are listed in the National Register of Historic Places (NRHP). An additional two historic properties listed in the NRHP have been identified in Vermilion and Iberia parishes.

Thirty-one archaeological sites have been identified within a one-mile buffer of the NER alternatives. The recorded sites include two prehistoric sites that have been determined potentially eligible for listing in the NRHP and nine archaeological sites that have been determined not eligible for listing in the NRHP. The remaining thirty have not been assessed. No previously recorded sites have been identified within the proposed borrow areas. Hundreds of standing structures that have a minimum age of 50 years have not been assessed for eligibility.

The information provided above is based upon a review of cultural resources literature and records maintained by the Louisiana Division of Archaeology and Division of Historic Preservation, and CEMVN has determined that additional investigations would be required to locate and define the boundaries of cultural resources within the area of potential effects (APE) for the NED and NER TSP. Additional archaeological sites and standing structures may be identified during the cultural resource investigations of the APE. The cultural resources investigations would also include eligibility determinations for archaeological sites and historic standing structures located within the APE. CEMVN has initiated Section 106 consultation, and the APE, research design and survey methodology will be determined through consultation with the Louisiana State Historic Preservation Officer, federally recognized Indian Tribes, and additional consulting parties. The results of the identification and evaluation of historic properties will be coordinated with the Louisiana SHPO, Tribes, and additional consulting parties, and the CEMVN will seek to identify ways to avoid, minimize, and/or mitigate impacts to historic properties and resources of religious and cultural significance to Tribes that may be impacted by the proposed action.

1.4.9 Aesthetics and Visual Resources

Based on available aerial photography, the visual conditions have changed significantly over the past twenty years due to the growth of urban development and the loss or conversion of swamps into marsh, or open water areas. Comparisons between the 1992 and 2010 photography show that the same public thoroughfares that are in place today were in place then; however, the scenery has changed from natural to a developed state with residential, commercial and industrial development dominating U.S. Highway 90, Interstate 10, and the state and parish roads surrounding Lafayette and Lake Charles. The areas in Cameron and Vermillion Parish are still relatively rural, giving the viewer near unobstructed views of a native landscape that has remained aesthetically pleasing. Primary view sheds then, as they are today, were best taken from the local road system.

There is one identified Scenic Stream, the Calcasieu River, located in the northeastern corner of Calcasieu Parish. The portion of Calcasieu River that qualifies as scenic stretches from the northeastern corner of Calcasieu Parish northeast into Allen Parish some 34 miles.

Access to the area is in abundance with highways and byways crisscrossing the region along with local streets and neighborhoods in the more developed portions. Scenic Byways include the Creole Nature Trail; which traverses State and Parish Highways 82, 27, 384, 385, and 397. This Scenic Byway is both state and federally designated and also has an “All American Road” status, making it significant in culture, history, recreation, archeology, aesthetics and tourism. Other Scenic Byways include the Zydeco Cajun Priairie Scenic Byway, located just north of Lafayette and the Jean Lafitte Scenic Byway, located just south of Lafayette. Both of these byways carry a state designation only, but are no less significant in their importance to the region in terms of tourism, scenic vistas, recreation, and the local economy.

1.4.10 Recreation Resources

Recreational features and opportunities vary throughout the coastal zone, habitat and culture playing significant roles in the diversity of activities. From the games and competitions of Native Americans, to the influence of diverse immigrant cultures, traditional recreation in Louisiana has been a product of its people. Nearly 10,000 years ago, people began living off the ample resources of Louisiana. The means by which Louisiana’s early residents lived, hunting and fishing for food, utilizing high ground for camps, and building vessels for transportation, shaped what is now recognized as traditional recreation in southern Louisiana.

State parks within the *Gulf Coast Prairie and Forested Terraced Uplands* physiographic regions include Palmetto Island and Sam Houston Jones parks. There are no Federal National Wildlife Refuges (NWR) or Wildlife Refuges (WR) within the regions. Eight boat launches are located within these regions. Access into the WMAs and refuges is generally by car or boat. Consumptive recreation includes hunting, fishing for freshwater and saltwater species and trapping alligators and nutria. Non-consumptive recreation includes bird watching, sightseeing, boating and environmental education/interpretation. Many of the parks offer hiking/biking trails, camping and picnic shelters.

Federal parks within or adjacent to the *Gulf Coast Marsh* physiographic region provide access to high quality recreational resources. From east to west, the region includes both state and NWR including: the 71,544-acre White Lake Wetlands Conservation Area, the 76,000-acre Rockefeller WR, the Lacassine NWR, Cameron Prairie NWR, and the 130,544-acre Sabine NWR. Nearly 450,000 people visited the NWR in 2012. Outside. but adjacent to the region, is Cypremont State Park, Shell Keys NWR and Marsh Island WR.

In addition to the high quality recreational fishing and hunting in the parks in the Gulf Coast Marsh region, several lakes and inland marshes offer opportunities for hunting and catching both freshwater and saltwater species. Grand, White, and Calcasieu Lakes and Vermillion Bay are prime fishing spots for recreational species such as redfish and speckled trout as well as flounder and brown and white shrimp. White Lake is a remote open lake and can only be accessed by the Schooner Bayou Canal, the old Intracoastal Canal north of Pecan Island or via the Superior Canal west of Pecan Island. The Calcasieu Lake area offers 10 of the 35 public or private boat launches in the area.

Bird watching is also an important recreational resource. A global initiative of BirdLife International, implemented by Audubon and local partners in the United States, the Important Bird Areas Program (IBAs) is an effort to identify and conserve areas that are vital to birds and other biodiversity. In the NER area, Audubon lists the entire Chenier Plain as a globally IBA (source: http://netapp.audubon.org/iba, accessed 25 September 2013). Many of the IBAs recognized are located within state or federally operated areas. Federal parks within the Chenier Plain that are globally IBAs include Lacassine NWR, Cameron Prairie NWR and Sabine NWR. Also in the area is the Baton Rouge Audubon Society 40-acre Peveto Woods Sanctuary located along the Louisiana coast in Cameron Parish. The Peveto Woods Sanctuary site is the most heavily birded locale in Louisiana and was the first chenier sanctuary for migratory birds established in Louisiana. Each spring and fall, Peveto Woods hosts most migratory songbirds native to eastern North America (source: http://www.braudubon.org/peveto-woods-sanctuary.php, accessed 25 September 2013). The State of Louisiana owns and operates the White Lakes Conservation Area, Rockefeller WR and the State Wildlife Refuge (SWR), all located in the Chenier Plain and all globally IBAs as is the Audubon/Paul J. Rainey Wildlife Sanctuary to the west and the Marsh Island Wildlife Refuge to the east. Finally, Palmetto Island State Park and just north of SWR, is an IBA.

Designated within Gulf Marsh region is the Creole Nature Trail National Scenic Byway, a 105-mile driving and walking tour touching four state and NWRs and a bird sanctuary. Finally, public and private boat launches are located throughout the entire region.

1.5 Need for Action

The processes of sea level rise, subsidence, saltwater intrusion, and erosion of wetlands in southwest coastal Louisiana have caused significant adverse impacts, including increased rates of wetland loss and ecosystem degradation. Without action, this highly productive coastal

ecosystem, composed of diverse habitats and wildlife, is not sustainable. Infrastructure constructed for access into and across the wetlands has modified the hydrology of the coastal zone, thus facilitating and accelerating saltwater intrusion and fragmentation, and conversion of wetlands to open water. Hurricane surge has formed ponds in stable, contiguous marsh areas and expanded existing, small ponds, as well as removed material in degrading marshes (Barras, 2009). Fresh and intermediate marshes appear to be more susceptible to surge impacts, as observed in Barras (2006).

Land loss and ecosystem degradation threaten the continued productivity of the area's ecosystems, the economic viability of its industries, and the safety of its residents. The following valuable social and economic resources are at risk:

- Commercial harvest of fishery resources
- Rice, crawfish, and cattle farming
- Recreational saltwater and freshwater fisheries
- Ecotourism
- Oil and gas production
- Petrochemical industries
- Strategic petroleum reserve storage sites
- Storm damage risk reduction, including hurricane storm buffers
- Navigation corridors and port facilities for commerce and national defense, and
- Actual and intangible value of land passed down through generations.

During the NEPA scoping process, stakeholders noted the following problems related to saltwater intrusion:

- As the Calcasieu Ship Channel widens and deepens, salinity levels increase after storm surge events and farmers have greater difficulty operating their rice farms.
- In the 2006 growing season, farmers were unable to plant because of high salinity levels caused by Hurricane Rita which overtopped local levees built in the 1940s or early 1950s.
- As a result of salinity encroachment in Calcasieu Lake, the Sabine Refuge is now a large open water area.
- Saltwater intrusion is occurring in the Calcasieu and Mermentau Basins and is in turn negatively impacting the seafood industry. Ship channels in the Calcasieu and Sabine Rivers are allowing saltwater movement into the upper estuaries.

During the past 11 years, the area has been greatly impacted by storm surges associated with three Category 2 or higher hurricanes -- Lili, Rita, and Ike -- which inundated structures and resulted in billions of dollars in damages to southwest coastal Louisiana. Hurricane surge also causes significant damage to wetlands. The breakup of marshes surrounding the towns and communities is allowing storm surge and inundation to more directly impact habitable areas. As a consequence, smaller storms are able to inflict significant flooding damages to residential and non-residential structures. As the coastal ecosystem continues to fragment, flooding losses are expected to increase, thus placing larger populations at risk.

1.5.1 Problems

The people, economy, unique environment and cultural heritage of southwest Louisiana are at risk due to storm surge flooding and wave impacts from tropical storms. The area's low elevation, proximity to the Gulf of Mexico, land subsidence, and rising sea level, are expected to exacerbate coastal flooding, shoreline erosion, saltwater intrusion, and loss of wetland and chenier habitats in the future.

System-wide problems and opportunities were used to identify and define more geographically specific problems and opportunities. Problems include the following:

- Flooding from tidal surge and waves associated with tropical storms.
- Increased flood durations in wetlands, resulting in wetland loss.
- Erosion of channel banks and shorelines, resulting in wetland loss.
- Deforestation and mining of chenier ridges.

1.5.2 Significance of Loss of Southwest Coastal Louisiana's 'Working Coast'

The area is uniquely suited to its current use of sheltering the infrastructure of the navigation, oil and gas, and seafood industries of the region. The 2012 State Master Plan and CPRAB describe the majority of the coast as privately owned; close working relationships with private landowners are essential, not only for their support but to gain from their knowledge about private coastal lands. (source: http://coastal.la.gov/a-common-vision/master-plan/principles/ accessed November 22, 2013).

- The loss of marsh and wetlands threatens the productivity of the region's coastal ecosystem, the economic viability of industries, and the safety of residents, a marine-resource based economy defined by the interactions of numerous stakeholders engaged in consumptive and non-consumptive uses of coastal resources.
- Southwest Louisiana's "Working Coast" is unique in its scope and scale, with extensive infrastructure needs to serve the navigation, oil and gas, and commercial and recreational fishing industries, needs which must be balanced and must exist in harmony with each other.
- The loss of marsh and wetlands would threaten nationally significant economic, historical, and cultural resources and have significant negative impact on the navigation, oil and gas, and seafood industries, and the residents that service these industries.

Navigation

- Wetlands provide protection to several federal navigation projects, including the GIWW, the Calcasieu River and Pass (providing access to the Ports of Lake Charles and Cameron), Sabine Pass (providing access to Port Arthur, Texas), and Freshwater Bayou (providing access to the Port of Iberia). With the loss of wetlands, the sustainability of the Federal navigation system in the region becomes less reliable and more expensive.
- The Port of Lake Charles is a deepwater seaport, on the U.S. Gulf Coast. The Port is currently the 13th-busiest seaport in the U.S.
- The loss of wetlands will expose federal navigation channels, and the ports to which they provide access, to increased erosion/shoaling, especially during extreme weather events, and may force the relocation or abandonment of certain channels and port facilities that currently serve the transportation and oil and gas industry requirements of the region and nation.

Oil and Gas (O&G) Infrastructure

- Regional ports serve the area's vast network of offshore oil and gas facilities, including production facilities and an extensive network of pipelines that provide the U.S. with needed energy resources. The area is also home to three of the 11 liquified natural gas import/export terminals in the U.S.
- The O&G industry encompasses production (active and passive), distribution of products from offshore/near shore sources throughout North America (via vast unseen pipeline distribution network), support service industry, and rig fabrication and service vessel building.
- The area provides O&G to both domestic and international markets through strategically laid pipelines. Even brief interruptions in service have significant impacts to the supply and pricing of gasoline and natural gas throughout the U.S.

- Erosion of wetlands could result in the displacement/damage of the region's strategic O&G industry infrastructure, especially the extensive near-shore pipeline network, resulting in disruption of service and increased repair and maintenance cost. Potential damage to pipeline network could increase the risk of unintended releases of petroleum products and the resulting ecosystem damage.

Seafood

- Southwest Louisiana has large commercial and recreational fishing industries that are dependent on the region's wetlands.
- The fisheries industry encompasses commercial fishing harvesting, distribution, and processing, fisheries support industry, boat building, and recreation fishing/hunting support (marinas, fishing charter/guide services, camps, bait/tackle shops).

Social

- Developments in the coastal zone are primarily smaller communities that support resource extraction and harvests in the agricultural, energy and fishing industries.
- While human populations in and near the wetland areas are low, Southwest Coastal Louisiana is a hub of activity supporting the numerous ports, waterways, oil and gas fields, rich fishing grounds, and other elements of a working coast.
- The impact of the loss of wetlands will be felt far beyond the industries directly impacted, with residents that serve these industries, especially the offshore oil and gas industry, being forced to abandon their communities and move further inland.

1.6 Opportunities

Opportunities to solve the problems include:

- Incorporate structural and nonstructural hurricane and storm surge reduction solutions to reduce the risk of damages and prevent loss of community cohesion (examples of how this can be accomplished include construction of levees, pump stations, interior drainage, elevating structures, or floodproofing).
- Improve internal system hydrology to restore wetlands (examples of how this can be accomplished include measures such as gates, weirs, or marsh restoration).
- Manage salinity levels to maintain fresh and intermediate marsh (examples of how this can be accomplished include water control structures or modifying hydrology).
- Reduce bank and shoreline erosion (examples of how this can be accomplished include rock armoring or breakwaters).
- Prevent loss of significant historic sites (examples of how this can be accomplished include levees, marsh restoration, or elevating structures).

1.7 Authorities

The study has both National Economic Development (NED) and National Ecosystem Restoration (NER) components. This stems from two separate authorizations.

The NED study was authorized for the Southwest Coastal Louisiana Feasibility Study following the impact of Hurricane Rita in 2005.

> *"Resolved by the Committee on Transportation and Infrastructure of the United States House of Representatives, that, in accordance with Section 110 of the River and Harbor Act of 1962, the Secretary of the Army is requested to survey the coast of Louisiana in Cameron, Calcasieu, and Vermilion Parishes with particular reference to the advisability of providing hurricane protection and storm damage reduction and related purposes to include the feasibility of constructing an armored 12-foot levee along the Gulf Intracoastal Waterway."* (December 7, 2005 – Committee on Transportation and

Infrastructure, U.S. House of Representatives, Resolution Docket 2747, Southwest Coastal Louisiana).

Investigation of the NER purpose was recommended in the 2005 Chief's Report for the Louisiana Coastal Area (LCA) Ecosystem Restoration Program. The Chenier Plain Freshwater and Sediment Management and Allocation Reassessment Study was one of six large-scale restoration concepts that were purported to have the ability to "significantly restore environmental conditions that existed prior to large-scale alteration of the natural ecosystem" upon construction. The LCA program was authorized in Title VII of the Water Resources Development Act of 2007.

Additional guidance is identified in Section 5007of WRDA 2007: Expedited Completion of Reports and Construction for Certain Projects. Guidance provided by the Director of Civil Works on December 19, 2008 states that *the coastal restoration components proposed as part of the LCA Chenier Plain study will be evaluated as part of the Southwest Coastal Louisiana feasibility study.*

1.8 Future Without Project Conditions

This section presents the future without project conditions for not implementing a Federal project or taking No Action. For Aesthetic Visual Resources and Noise there would be no direct, indirect or cumulative impacts resulting from taking no action and therefore are not discussed further in this section.

1.8.1 Human Environment

1.8.1.1 Population and Housing

Changes in population, households, and housing are expected to follow the growth in employment within the area. Recent trend analysis (Moody's Analytics 2008) indicates an increase of 15,000 residents and approximately 5,600 residential structures projected for the area which will impact estimates of employment, as described in the next section. Generally, the overall population is projected to increase. However, the Cameron Parish population is projected continue its trend of decreasing since 2000 (table 1-16).

Parish	Population		
	2020	2030	2080
Calcasieu	195.0	200	236.7
Cameron	6.6	6.6	3.9
Vermillion	59.9	63	76.8
Total	261.4	269.6	317.4

Table 1-13: Projected parish population (in thousands).

A single catastrophic storm surge event or multiple events could result in significant damage to economic assets including primarily residential, commercial, and industrial structures. Additionally, property owners could potentially incur higher insurance premiums offered by the National Flood Insurance Program (NFIP) should flood rate insurance maps (FIRM) be updated to reflect an increase in risk over time due to relative sea level rise.

Indirect impacts include an increased potential for flood damage to economic assets due to relative sea level rise. As a consequence of this increased flood risk, property owners and the NFIP (if insured) over time would together incur increased costs to repair flood-damaged property. Additional costs to implement appropriate mitigation measures to address potential increased flood risk would also be incurred. Such mitigation could include the migration (or displacement) of affected populations from areas exposed to high flood risk to area with relatively lower flood risk. Migration out of the area could also arise from the temporary or permanent relocation of businesses and employment opportunities.

1.8.1.2 Employment, Business, and Industrial Activity (including Agriculture)

Indirect impacts would include a higher potential for temporary interruption or permanent displacement of employment, business, and industrial activity as businesses temporarily or permanently relocate to areas with less storm damage risk. Growth in employment, business and industrial activity is expected to follow national economic trends to the extent that economic growth is dependent upon macroeconomic variables such as inflation, interest rates, and the business cycle. However, employment in this region is also partially dependent on the petroleum exploration, production, and refining industries, which do not necessarily correlate with national economic trends. Employment trends (Moody's Analytics 2008) suggests growth from 2012 to 2038 with an additional 6,880 jobs projected by the year 2038 (table 1-17). Cameron Parish, employment is expected to stabilize at 2012 levels (Moody's Analytics 2008).

Table 1-14: Projected non-farm employment (in thousands).

Parish	2012	2020	2030	2038
Calcasieu	91.89	96.5	95.5	95.4
Cameron	2.69	2.8	2.7	2.7
Vermilion	16.54	17.7	18.4	19.9
Total	111.12	116.9	116.5	118.0
Source: Moody'sAnalytics				

One or more series of catastrophic storm surge events in the future could result in significant disruption to business and industrial activity that could adversely affect employment and population. Such catastrophic events causing significant damage to non-residential, commercial, and industrial structures would likely increase over time as a result of multiple factors such as relative sea level rise and global warming (source: http://www.climatehotmap.org/global-warming-effects/economy.html accessed October 30, 2013). Additionally, business owners in these communities could potentially incur higher flood insurance premiums should the FIRMs be updated to reflect an increase in flood risk over time.

1.8.1.3 Public Facilities and Services

Indirect impacts would include a greater potential for permanent displacement of public facilities and services due to storm surge events. Public facilities and services are expected to grow with the needs of the population and would follow population growth trends. In addition to the existing 603 public and quasi-public buildings, an additional 193 such facilities are projected by 2080. These projected facilities are expected to be placed at elevations above the 100-year floodplain. Over time, all facilities would be more susceptible to damages resulting from future hurricane and storm surge events as relative sea level rise occurs. The increased risk of damage to public facilities and the resulting temporary or potentially permanent relocation of these facilities would have a negative impact on services which would no longer be available either temporarily or permanently.

1.8.1.4 Transportation

Transportation infrastructure would be more susceptible to damages resulting from storm surge events due to expected RSLR. There would also be reduced access to infrastructure due to storm surge.

1.8.1.5 Community and Regional Growth

Income growth and associated community and regional growth are expected to follow trends in national income, local employment, household formation, and the demand for public facilities and services. There would also be a higher potential for unstable or disrupted community and regional growth due to increasing risk of damage from storm surge events.

1.8.1.6 Tax Revenues and Property Values

Indirect impacts would include lower tax revenues as property values decline due to higher risk of damage from storm surge events over time. The real estate market cycle is the primary factor in establishing existing and future property values at any point in time. However, over the period of analysis (50 years) changes in property values would be primarily reflective of the growth in income. As flood risk grows over time due to higher surge events as a feature of relative sea level rise, the effects of higher flood risk would continue to suppress real estate market values for residential and non-residential properties. As in other coastal regions, higher flood risk would manifest itself in higher premiums for flood insurance under the NFIP: higher premiums are expected to increase the cost of property ownership and result in correspondingly lower market values. In extreme cases, such premiums are expected to rise to such high levels that the cost of flood insurance would become prohibitively expensive to some property owners. As a result, some properties would not be marketable and their values be reduced to an extremely low level. To the extent that government assessments of these properties accurately reflect the diminished market values, the tax base would be reduced and property tax revenues decline.

Some property owners would choose to reduce higher expected future flood risk through mitigation activities. These activities would primarily include, but are not limited to, structure elevation, flood-proofing of commercial structures, and relocation to less risky portions of the study area. Each of these mitigation efforts require substantial financial resources to implement, whether these costs are borne by the property owner or are supplemented, in whole or in part, by public assistance.

1.8.1.7 Community Cohesion

The area would become more susceptible to damage caused by storm surge events that is projected to increase over the period of analysis. The increased risk of damage to residential and non-residential structures and the resulting temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities. Additional indirect effects would include a greater potential reducing community cohesion if the civic infrastructure continues to be damaged as a result of storm surge events. Community cohesion may also be reduced if residents and businesses relocate to lower-risk areas.

1.8.1.8 Other Social Effects (OSE)

The area's social vulnerability is expected to increase over time if subsidence and sea level rise continue to increase, and the population in the study area increases as it is projected to do. The absolute number of socially vulnerable people (e.g., low-income, minority, less-educated, and over the age of 65) at risk for flood events will increase. This, in turn, may lead to an increased burden placed on local, state, and federal agencies to ensure that the most socially vulnerable populations have access to resources before, during, and after flood events.

1.8.1.9 Environmental Justice

Indirect impacts would include a higher potential for temporary displacement of minority and/or low-income populations because residents within the project area would remain vulnerable to flooding and may be forced to relocate to areas with risk reduction features in place. Storm surge increase due to subsidence and sea level rise will exacerbate their vulnerability to flooding. Low-income populations may also find it more difficult to bear the cost of evacuation.

The future-without alternative would not contribute to any additional EJ issues when combined with other Federal, state, local, and private risk reduction efforts.

1.8.2 Water Environment

1.8.2.1 Relative Sea Level Rise

Sea level rise (SLR) conditions were simulated by incorporating the predicted subsidence levels into the initial water elevation parameter to capture the combined effects of subsidence and local SLR into a single RSLR value. For the 2025 and 2075 hydrologic simulations, RSLR values specific to each gage were added to the 2013 initial water surface elevations (WSE) to calculate the initial WSE appropriate for each year and SLR rate. SLR and RSLR data is listed in table 1-8 and shown in figure 1-6. Four gages were used for the entire RSLR analysis, however only the gage closest to the main area with potential benefits is shown.

Table 1-15: RSLR rise for the gage on the GIWW west of Calcasieu Lock.

Year and SLR Scenario	Calcasieu West RSLR increment (in feet)	Calcasieu West gage elevations (NAVD88 feet)
2025 Low SLR	0.16	0.78
2025 Intermediate SLR	0.22	0.84
2025 High SLR	0.40	1.02
2075 Low SLR	0.85	1.47
2075 Intermediate SLR	1.42	2.04
2075 High SLR	3.24	3.86

1.8.2.2 Hydrology and Hydraulics

In the immediate area of Lake Charles, 100-year frequency event water levels are estimated to rise between 0.47 feet and 1.19 feet between 2013 and 2075. In the surrounding marsh areas for all parishes, water levels are estimated to rise between 1.30 feet and 7.40 feet. For the areas along I-10 such as Welsh, Jennings, and Crowley that are far away from any water source connected to the Gulf of Mexico, there is no estimated rise in water surface elevations. This data is shown in tables in the Engineering report - Southwest Coastal Louisiana Explanation of FWOP Results. This analysis is based upon the intermediate rate of relative sea level rise. Adding marsh accretion raises water levels slightly in the marsh areas, while not impacting any NED areas.

1.8.2.3 Flow and Water Levels

Indirect impacts would be continuation of the existing water flow and water level trends. As existing marsh fragments and is eventually converted to open water, the rainfall runoff from the north and the increasing sea level rise would result in the area converting to greater expanses of fragmented marsh and open water. As sea levels rise, existing locks and control structures used for salinity control would be closed on a more frequent basis over time until they would be closed all the time to prevent saltwater intrusion. Natural drainage pattern flow paths would remain unchanged; however, as sea levels rise, drainage times would increase.

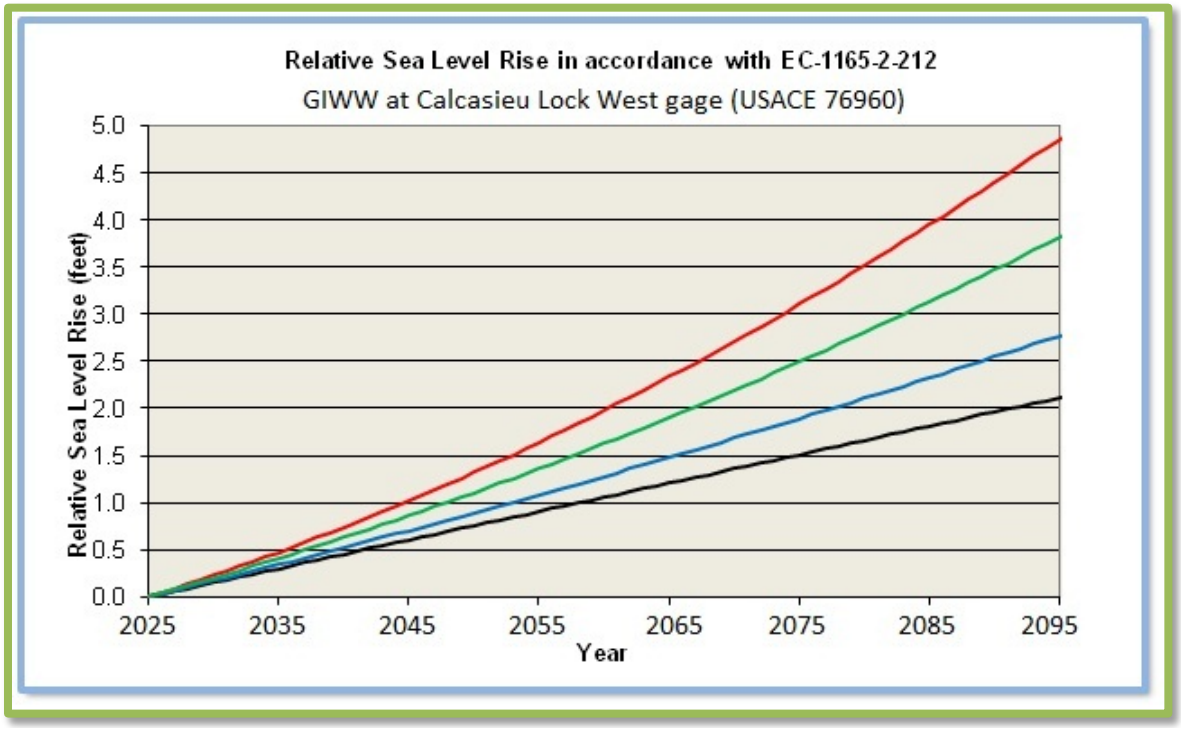


Figure 1-3: Relative sea level rise in the study area.
Black = extrapolation of historic rate Blue = low RSLR. Green = intermediate RSLR. Red = high RSLR.

1.8.2.4 Water Quality and Salinity

Existing water quality trends would be expected to continue. Without the proposed project there would be an increased risk of flooding of the urban areas, and drainage of floodwaters containing elevated nutrients, metals, and organics into waterbodies connected to the Calcasieu, Mermentau, and Tech-Vermillion river basins is a possibility. Without the proposed project, study area would still be affected by existing and proposed restoration efforts, chenier geomorphologic processes, development (in particular, oil and gas development in the Calcasieu River basin and agriculture in the Mermentau River basin), and climate patterns (Mousavi et. al 2011).

1.8.3 Natural Environment

1.8.3.1 Sedimentation and Erosion

Indirect effects would include persistence of current sedimentation and erosion patterns. Relative sea level rise would expose additional shoreline areas to erosive forces into the foreseeable future. Existing hydrologic alterations would continue to impact water levels and salinities and continue influencing land loss at similar or increased rates.

North White Lake in the Mermentau Basin is expected to lose approximately 3,500 acres of freshwater marsh by 2050 (Coast 2050) resulting from shoreline erosion. South White Lake is expected to lose approximately 4,200 acres of freshwater marsh by 2050. The Vermilion Bay Marshes are expected to lose 13,560 acres of marsh by 2050 (Coast 2050). Rainey Marsh is expected to lose approximately 7,900 acres by 2050 (Coast 2050).

1.8.3.2 Soils, Water Bottoms and Prime and Unique Farmlands

Indirect effects would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change. As RSLR increases and areas become inundated by salt water, prime farmlands could be lost.

As human populations and development increase, prime farmlands could be converted to suburban, urban, and industrial uses and areas available for agricultural use would decrease.

Gulf shoreline recession rates, varying between 8 feet to 52.9 feet per year, would result in Gulf shoreline rollover onto back barrier marsh and cheniers would continue to be lost throughout the southwest coastal area due to subsidence and change in land use patterns from forested areas to agriculture and grazing pasture. Soils identified as prime farmlands on chenier ridge tops would be susceptible to flooding events and subsidence and could be lost as RSLR increases.

1.8.3.3 Gulf Coastal Shorelines

Indirect effects would be the continuation of existing conditions with coastal shoreline recession, subsidence and land loss continuing at similar or increasing rates of change. The loss of these coastal shorelines would also adversely impact the extraordinary scenic, scientific, recreational, natural, historical, archeological, cultural, and economic importance of the coastal shorelines. The continued loss of coastal shorelines would result in the reduction and eventual loss of the natural protective storm buffering. Without the protective buffer provided by the coastal shorelines, interior estuarine wetlands would be at an increased risk to severe damage from tropical storm events. Continued shoreline recession, subsidence and land loss resulting in the movement of unstable sediments would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this “working coastline.”

1.8.3.4 Vegetation Resources

Indirect effects would be the continuation of existing conditions and factors driving trajectories of ecological change to area vegetation zones. Without an extensive ecosystem restoration plan, marsh habitat would continue to be restored through other restoration projects and programs such as those authorized for construction through CWPPRA, CIAP, and LCA, but not on a large and broad enough scale to completely restore natural processes and features vital to the long-term sustainability of the watershed. Without action, the coastal vegetated resources would continue to decline, including bankline erosion and sloughing of the shoreline, and continued fragmentation and conversion of existing brackish and saline marsh to shallow open water habitats. Both human-induced impacts and natural processes would contribute to the continued loss of vegetated habitats, including continued shoreline erosion and subsidence, increased saltwater intrusion, increased water velocities, and increased herbivory.

Gulf Coast Prairie and Forested Terraced Uplands:

- Some unknown extent of existing riverine BLH and associated swamp habitats would be converted to more efficient water conveyance channels as human populations and development increase.
- Some unknown extent of existing pasture and rangelands would be converted to rural, suburban and urban human habitats, generally in the order presented, as human populations and development increase.

Gulf Coast Marshes

- Habitat switching would occur due to increasing sea level rise, subsidence, shoreline erosion and other land loss drivers.
- Gulf shoreline recession rates, varying between 8 feet to 52.9 feet per year, would result in Gulf shoreline rollover onto back barrier marsh thereby converting these existing habitats.

- Chenier ridge habitat is being lost throughout the southwest coastal area due to subsidence and change in land use patterns from forested areas to agriculture and grazing pasture. However, no loss of chenier habitat is anticipated within the proposed restoration areas because these areas are at least +4 foot NAVD88.
- Inland ponds and lakes shoreline loss rates, varying between 3.6 feet and 9.3 feet, would result in conversion of existing salt, brackish, and intermediate/fresh marsh to shallow open water habitats.
- Habitat switching of interior marsh could result from saline intolerant dominant species to species that can tolerate higher salinities.
- SAVs could become lost due to erosive forces and increased sedimentation due to land loss.

Reference Table 1-13 for the NER restoration feature habitat type, acres and quality by hydrologic basin for comparision between the future without and with project condition (reference chapter 2 and 4 for plan formulation details and description of the NER TSP) .

Table 1-16: NER features by basin.

Basin	Category	Feature	Habitat Type	FWOP Acres	FWP Acres	NET AAHUs[1]
Mermentau/Teche-Vermilion	Hydrologic/ Salinity Control	13	Unknown		~2,791 [2]	11[2]
	Marsh Restoration	47a1	Brackish	0	895	378
		47a2	Brackish	0	1,218	517
		47c1	Brackish	0	1,135	497
		127c3	Brackish	0	735	320
		306a1	Brackish	1,945	2,688	362
	Shore Protection/ Stabilization	6b1	Saline	0	2,140	678
		6b2	Saline	0	1,583	499
		6b3	Saline	0	1,098	326
		16b	Brackish	1,456	2,744	212
	Chenier Restoration	CR	BLH	252	242 planted	85[3]
Calcasieu/Sabine	Hydrologic/ Salinity Control	74a	Unknown		~ 1,395[2]	-83[2]
	Marsh Restoration	3a1	Brackish	0	454	252
		3c1	Brackish	0	1,451	705
		124c	Saline	248	2,163	1,059
		124d	Saline	307	475	104
	Shore Protection/ Stabilization	5a	Barrier Headland	0	26	56[3]
	Chenier Restoration	CR	BLH	459	426 planted	173[3]
	Oyster Reef Preservation	ORP	Oyster Reefs		~1,480 [4]	N/A[4]

The numbers used to feed the WVAs were pulled from State of Louisiana Master Plan Modeling effort.
[1]A non certified version of the WVA model was used for all Marsh Restoration features. A sensitivity analysis needs to be done to see if using the certified model would change the outcome of the plan selection.
[2] Separate WVAs were not run for the Hydraulic/Salinity Control features. The numbers presented here are based on WVAs run for multiple features and are mathematical subtractions from plans with and without

the feature.
[3] The BLH and Barrier Headland WVA models used are certified models with no restrictions on use.
[4] No habitat model was used to determine the value of this feature. A certified model needs to be run to determine the value.

1.8.3.5 Rare, Unique, and Imperiled Vegetative Communities

Existing conditions and trends of land loss are expected to continue resulting over time in the loss of these valuable vegetative communities. For example, without action, saltwater intrusion and drainage problems would continue, resulting in the conversion of freshwater marsh to intermediate and brackish marsh and eventual open water.

1.8.3.6 Wildlife Resources

Existing conditions and changes caused by ecosystem drivers would persist. RSLR, human encroachment and development and other factors would result in loss of existing wildlife estuarine, chenier, riverine and oak-pine forest habitats. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water. As habitat loss continues, migratory neotropic avian species would have less habitat for resting forcing them to fly further to suitable habitat. Flying longer distances to find suitable stopover habitat could result in an increase in mortality resulting in a corresponding reduction in overall species diversity and abundance. Most mammalian, amphibian and reptilian species would migrate to more suitable habitats. Wildlife would benefit from restoration activities implemented by other programs such as CIAP, CWPPRA, beneficial use of dredged material; However these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.8.3.7 Aquatic and Fisheries Resources

Existing conditions and associated changes due to ecosystem drivers would likely persist into the future. Increases in RSLR would increase saltwater intrusion and exacerbate ongoing conversion of estuarine wetlands to shallow open water and loss of existing estuarine fish habitats. Increases in RSLR could exacerbate ongoing conversion of existing aquatic organism distributions from an estuarine-dependent to more marine-dependent distribution. As habitat loss continues, there would be a corresponding reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia and other estuarine aquatic habitats. Aquatic and fisheries would benefit from restoration activities implementated by other programs such as CIAP, CWPPRA, beneficial use of dredged material; However these activities are not enough to keep up with the current trends in habitat loss and RSLR.

1.8.3.8 Essential Fish Habitat (EFH)

Existing trends and continued shoreline erosion, subsidence and land loss would continue to convert existing estuarine EFH to marine and open water EFH types resulting in the loss of existing estuarine EFH but an increase in the other types.

1.8.3.9 Threatened/Endangered Species and Other Protected or Species of Concern

Land loss would directly reduce the availability of habitat for T&E species. Piping plover would lose access to some forage and roosting habitat as it shifts to shallow open water. As interior marshes are lost, shoreline retreat rates increase. The coastal habitat utilized by sea turtles would continue to be impacted from this accelerated shoreline retreat rate. The continued erosion of the Gulf coast shoreline would result in additional salt water intrusion into the interior wetlands area resulting in additional marsh loss. Conversely, the recently delisted brown pelicans would gain access to more shallow water foraging areas, resulting from the shoreline

retreat. Indirect effects would be the continued reduction of piping plover critical wintering habitat due to coastal erosion. The primary consequence of not implementing the NER plan would be the continued degradation and loss of emergent wetland habitats used by many different fish and wildlife species for shelter, nesting, feeding, roosting, cover, nursery, and other life requirements. The loss and deterioration of transitional wetland habitats over time could continue to indirectly affect, to an undetermined degree, all listed species that may potentially utilize the area including: Gulf sturgeon, piping plovers, green sea turtles, Kemp's Ridley sea turtles, loggerhead sea turtles, hawksbill sea turtle, leatherback sea turtle, and the West Indian manatee. The recovery of some sensitive/delisted species such as brown pelican, bald eagle, and colonial nesting birds could be indirectly impacted if habitat loss goes unabated.

1.8.3.10 Cultural and Historic Resources

Impacts to historic and cultural resources in southwest Louisiana have resulted from both natural processes, such as redeposition, and human activities. Coastal environments are dynamic, and impacts to cultural and historic resources in the area would continue as a result of both natural processes and cultural modifications of the coastal environment of southwest Louisiana.

1.8.3.11 Recreation Resources

Recreational resources in the Louisiana coastal zone that would be most affected are those related to loss of wetlands/marshes and habitat diversity. Many recreational activities are based on aquatic resources and directly related to the habitat and species in an area.

Gulf Coast Prairie and Forested Terraced Uplands: Indirectly, recreational infrastructure would remain vulnerable to surges. Another major impact of storm surge is land loss and the possible loss of facilities and infrastructure that support or are supported by recreational activities. Land loss can result in the loss of park land, boat launches, parking areas, access roads, as well as marinas and supply shops. In general, without an adequate hurricane protection system, further degradation of area marshes would continue and its associated negative effects on wildlife activities will increase. Additionally, saltwater intrusion and predicted sea-level rise will continue to cause land loss. As existing freshwater wetland/marsh areas convert to saltwater marsh, then to open water, the recreational opportunities will change accordingly.

Gulf Coast Marshes: Indirectly, the continued loss of wetlands/marshes and habitat diversity affects recreational opportunities. Storm surge and saltwater could have a negative impact on freshwater forests and habitats and could reduce recreational resources (e.g., fishing, hunting, bird watching, and other). In general, further degradation of area marshes would continue and its associated negative effects on recreation activities would increase. As existing freshwater wetland/marsh areas convert to saltwater marsh, then to open water, the recreational opportunities would change accordingly. For example, fresh water fishing opportunities may be expected to become saltwater opportunities. If the expected peak and then decline of fishery production occurs in these open waters, then the associated marine-fishery recreational opportunities would also decline. As populations of migratory birds and other animals dependent on marsh and swamp decrease, again associated recreational opportunities, such as hunting and wildlife viewing, would decrease. There may be an economic loss felt by marinas and other shops, which may be two-fold. One is losing the actually facility or access to the facility, the other is change in opportunities. Habitat change and resulting changing recreation opportunities (i.e. fresh to marine) may, for example, severely impact a marina specializing in services to particular types of recreation (i.e. loss of freshwater opportunities).

1.9 Cumulative Impacts for Future Without Project Conditions

Cumulative impacts would be the incremental direct and indirect effects of not implementing proposed NED and NER efforts. These incremental effects would be in addition to the direct and indirect effects attributable to the lost opportunity of not implementing other HSDRR or ecosystem restoration efforts which have been considered, but for whatever reasons are not or would not be implemented.

There is little published data with which to provide a quantitative comparison regarding HSDRR or ecosystem restoration projects which have been considered but have not been authorized for implementation or have not been constructed throughout Louisiana. Some information regarding such efforts:
The 1990 Coastal Wetlands Coastal Wetlands Planning, Protection and Restoration Act, (CWPPRA; Public Law 101-646, Title III CWPPRA).
The 1998 *Coast 2050: Toward a Sustainable Coastal Louisiana* plan to address Louisiana's costal land loss and provide for a sustainable costal ecosystem. This collective effort among Federal, State, and local governments was affirmed by the adoption of the plan by the Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority as their official restoration plan; transmission of this plan to the U.S. Department of Commerce by the State of Louisiana to incorporate it into the Louisiana Coastal Resources Program Guidelines; and resolutions of support from 20 coastal parish councils and police juries.
The Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study (hereinafter "LCA Plan," USACE 2004).
Louisiana's Comprehensive Master Plan for a Sustainable Coast (hereinafter "2012 State Master Plan; CPRA 2012).

Since its inception, the CWPPRA program has authorized for construction 151 coastal restoration or protection projects, benefiting over 110,000 acres in Louisiana (source: http://lacoast.gov/new/About/#projects accessed October 22, 2013). However, hundreds of ecosystem restoration projects have been considered as candidate or demonstration projects. Of these, approximately 253 projects were not selected for detailed consideration (personal communication Ms Susan Hennignton, USACE Representative CWPPRA, on October 24, 2013).

The LCA Plan identified 15 projects. Six LCA feasibility studies were approved in 2010 and a PED agreement executed in 2011. In 2012 the state changed direction and withdrew their support for four of the six projects and indicated their intent to pursue those efforts independently or through other partnerships. In October 2012 the state requested suspension of the "LCA 4" ongoing feasibility studies. As of November 2013, only one LCA feasibility study is underway-- the development of river modeling tools to be used in assessing management of the Mississippi River delta. This study is scheduled to be completed in fiscal year 2016. In the LCA Program the State is expected to continue to partner with the USACE on the advancement of the Small Diversion at Convent/Blind River projects (currently in design), and to construct the Caminada Headland component of the Barataria Basin Barrier Shoreline project (currently in design by the State) and Demonstration Projects (currently developing program implementation plans). The State has declined to participate in the LCA BUDMAT program; however, agreements with another non-federal cost share sponsor are presently being negotiated.

The 2012 State Master Plan (CPRA 2012) states that more than 23 large-scale studies and planning efforts have been conducted for coastal Louisiana since the 1920's. The State developed and screened over 1,500 project ideas to develop a more manageable number of candidate projects. From this, the State evaluated 248 restoration projects, 33 structural and

116 conceptual non-structural flood risk reduction projects. The State acknowledges that each project has its own timeline and budget. The 2012 State Master Plan indicates how the State of Louisiana would spend dollars they now have in hand as well as how they would use new dollars that are allocated for Louisiana's coast. It is reasonably foreseeable that some of the identified projects would likely not be constructed.

In response to the 2012 Gulf of Mexico Deepwater Horizon oil spill to help ensure the long-term restoration and recovery of the Gulf Coast region, the Resources and Ecosystems Sustainability, Tourist Opportunities, and Revived Economies of the Gulf Coast States Act of 2012, or the RESTORE Act (herein referred to as Act), was passed by Congress on June 29, 2012, and signed into law by President Obama on July 6, 2012 ((http://www.restorethegulf.gov/sites/default/files/The%20Path%20Forward%20to%20Restoring%20the%20Gulf%20Coast%20-%20Gulf%20Restoration%20Council%20FINAL.pdf accessed November 22, 2013). The Act provides for planning and resources for a regional approach to the long term health of the natural ecosystems and economy of the Gulf Coast region. The Act sets forth the following framework for allocation of the Trust Fund (http://www.restorethegulf.gov/release/2012/11/30/gulf-coast-ecosystem-restoration-council-help-rebuild-gulf-coasts%E2%80%99-ecosystems-and accessed November 22, 2013):

- 35 percent equally divided among the five States for ecological restoration, economic development, and tourism promotion;
- 30 percent plus interest managed by the Council for ecosystem restoration under the Comprehensive Plan;
- 30 percent divided among the States according to a formula to implement State expenditure plans, which require approval of the Council;
- 2.5 percent plus interest for the Gulf Coast Ecosystem Restoration Science, Observation, Monitoring and Technology Program within the Department of Commerce's National Oceanic and Atmospheric Administration (NOAA); and
- 2.5 percent plus interest allocated to the States for Centers of Excellence Research grants, which will each focus on science, technology, and monitoring related to Gulf restoration.

The Act requires the Initial Comprehensive Plan (Plan) to include "a list of projects and programs authorized prior to the date of enactment of [the Act] but not yet commenced, the completion of which would further the purposes and goals of [the Act]." The Department of Agriculture identifies 8 projects; U.S. Forest Service identifies 3 projects; Department of Commerce identifies 6; Department of Interior identifies 3 projects; Louisiana identifies 6 projects; USACE identifies 42 projects; EPA identifies 6 projects specific to Louisiana and 1 project Gulf-wide (http://www.restorethegulf.gov/sites/default/files/Authorized%20But%20Not%20Yet%20Commenced%20List_8-6-13_FINAL.pdf?utm_medium=email&utm_source=govdelivery accessed November 22, 2013):

In 2013, the Coastal Protection and Restoration Authority (CPRA) submitted a request for a Department of Army permit pursuant to Section 404 Clean Water Act and Section 10 of the Rivers and Harbors Act and permissions under the 33 U.S.C. Section 408 for a proposed action on the Mid-Barataria Sediment Diversion. The project involves structural crossings of the Federal Mississippi River and Tributaries Levee and the future NEW Orleans to Venice Hurricane Protection Levee and could impact the Mississippi River Navigation Channel, Davis Pond Freshwater Diversion as well as other Federal projects. The CEMVN intends to prepare an EIS. The notice of intent was published in the Federal Register/Vol. 78, No. 193/Friday, October 4, 2013.

The cumulative effects of not implementing the proposed action would include the incremental effects of not providing HSDRR and/or ecosystem restoration on the following:

Human Environment

- an estimated population of 225,000 and 15,000 residential structures in the study area in the year 2075;
- employment of 106,000 workers in the three-parish area in the year 2010; 1580 non-residential structures in the study area by 2075; 808,414 acres of agricultural land within the three-parish area in 2009 projected 603 public and quasi-public buildings, and an additional 193 such facilities projected by 2080;
- transportation infrastructure would be more susceptible to damages resulting from storm surge events due to expected RSLR
- reduced access to infrastructure due to storm surges;
- community and regional growth;
- tax revenues and property values;
- higher flood insurance premiums would be expected to increase the cost of property ownership and result in correspondingly lower market values;
- continued or increased risk of damage to residential and non-residential structures resulting in temporary and/or permanent relocation of populations would negatively affect the community cohesion in many communities;
- continued temporary displacement of minority and/or low-income populations because residents within the area would remain vulnerable to flooding and may be forced to relocate to areas with risk reduction features in place;
- continued higher flood risks would manifest itself in higher premiums for flood insurance under the NFIP
- continued shoreline recession, subsidence and land loss resulting in the movement of unstable sediments would undermine man-made structures, especially the extensive oil and gas pipelines and related structures in this “working coastline;”

Water Environment

- existing hydrologic alterations would continue to impact water levels and salinities and continue influencing land loss at similar or increased rates;
- as sea levels rise, natural drainage pattern flow paths would remain unchanged but drainage times would increase;
- continued salt water intrusion and inundation during hurricane and storm surge events;
- continued erosion by wave and current action resulting in continued shoreline erosion of most channels, lakes, and the Gulf;

Natural Environment

- continued loss of soil resources. The LCA Study (USACE, 2004) estimated coastal Louisiana would continue to lose land at a rate of approximately 6,600 acres per year over the next 50 years. It is estimated that an additional net loss of 328,000 acres may occur by 2050, which is almost 10 percent of Louisiana’s remaining coastal wetlands. However, these wetland soil losses would be offset to some extent by restoration projects implemented through other programs.
- continued increases in RSLR which could increase saltwater intrusion and exacerbate ongoing conversion of existing estuarine wetlands to shallow open water; impacts to cultural and historic resources in the area would continue as a result of both natural processes and cultural modifications of the coastal environment of southwest Louisiana;
- recreational infrastructure would remain vulnerable to hurricanes and storm surges.

- continued conversion of existing vegetated wetlands used as foraging, nesting, and over-wintering habitat to open water habitats;
- reduction in overall species diversity and abundance as well as loss of estuarine nursery, foraging, refugia and other estuarine aquatic habitats;
- continued bankline erosion and sloughing of the shoreline;
- continued encroachment of salinity in areas with brackish and freshwaters;
- continued habitat switching due to increasing RSLR, subsidence, shoreline erosion and other land loss drivers;
- loss of habitat would further stress species that are dependent on these habitats for all or a part of their life cycle.

2.0 PLAN FORMULATION

Plan formulation is the key to supporting the U.S. Army Corps of Engineers (USACE) Civil Works water resources development mission. It is a process requiring experience, analysis, intuition, and inspiration. To ensure that sound decisions are made, the process requires a systematic and repeatable approach. The 1983 Principles and Guidelines published by the United States Water Resources Council, in describing the study process for Federal water resource projects, requires the systematic formulation of alternative plans that contribute to the Federal objective.

Plans or alternatives are composed of measures. Measures consist of features which are structural elements that require construction or assembly and/or activities which are nonstructural actions implemented to address planning objectives. Each feature and/or activity represents a measure that can be implemented to address planning objectives at a specific geographic site.

This study considered measures to accomplish objectives pursuant to National Economic Development (NED) and National Ecosystem Restoration (NER), and to maximize project benefits. All measures were evaluated and screened for capability to meet objectives and avoid constraints, for engineering and economic feasibility, and for the amount of benefits provided over the 50 year period of analysis from 2025 - 2075. Measures that warranted continued consideration and met the success thresholds were assembled into alternative plans. In the evaluation process, each alternative plan was required to meet study-specific minimum standards and qualifying criteria in order to merit further consideration. Each plan was evaluated individually to determine whether it qualified for additional consideration.

Risk Reduction

The term “100-year level of risk reduction,” refers to a level of reduced risk of hurricane and storm surge and wave driven flooding that the project area has a 1 percent chance of experiencing each year. The 1 percent chance is based on the combined chances of a storm of a certain size and intensity following a certain track. Different combinations of size, intensity, and track could result in a 100-year surge event. The 50-year level of risk reduction refers to a level of reduced risk of hurricane and storm surge and wave driven flooding that the project area has a 2 percent chance of experiencing each year. The 200-year level of risk reduction refers to a level of reduced risk of hurricane and storm surge and wave driven flooding that the project area has a 0.5 percent chance of experiencing each year.

2.1 Goals and Objectives

Generally, the planning goals of the NED Plan are to reduce hurricane and storm surge flooding and associated coastal storm damages. The NED storm damage risk reduction plans were formulated to achieve NED principles and objectives. Contributions to NED are increases in the net value of the national output of goods and services, expressed in monetary units, and are the direct net benefits that accrue in the planning area and the rest of the Nation.

The general planning goals of the NER Plan are to evaluate coastal restoration components and significantly and sustainably restore environmental conditions for the Chenier Plain ecosystem in Southwest Coastal (SWC) Louisiana to address a multitude of ecosystem problems associated with land loss and coastal erosion in the study area. Plans were formulated to achieve NER principles and objectives. Contributions to NER are increases in the net quantity and/or quality of desired ecosystem resources, and are measured in the study area and nationwide.

The following specific planning objectives were identified:

- NED Objective 1. Reduce the risk of damages and losses from hurricane and storm surge flooding.

- NER Objective 2. Manage tidal flows to improve drainage, and prevent salinity from exceeding 2 parts per thousand (ppt) for fresh marsh and 6 ppt for intermediate marsh.

- NER Objective 3. Increase wetland productivity in fresh and intermediate marshes to maintain function by reducing the time water levels exceed marsh surfaces.

- NER Objective 4. Reduce shoreline erosion and stabilize canal banks to protect adjacent wetlands.

- NER Objective 5. Restore landscapes, including marsh, shoreline, and Cheniers to maintain their function as wildlife habitat and improve their ability to serve as protective barriers.

2.2 Constraints

The NED and NER plans are limited by the following constraints that are to be avoided or minimized:

- **Commercial navigation.** The Calcasieu and Sabine Ship Channels and the Gulf Intracoastal Waterway (GIWW) carry significant commercial navigation traffic. Measures that would cause shipping delays would result in negative NED impacts. In addition, the ability of authorized navigation projects to fulfill their purpose, such as the operation of locks along the GIWW, may be impacted by project features.
- **Federally threatened and endangered species and their critical habitats.** Construction schedules may be restricted due to threatened and endangered species such as Piping Plover, Gulf Sturgeon, Red-Cockaded Woodpecker, Red Knot, Whooping Crane, West Indian Manatee, and several species of sea turtles.
- **Essential fish habitat (EFH), especially intertidal wetlands.** Conversion of one EFH type to another should be done without adversely impacting various fish species.
- **Historic and cultural resources.** Ninety-nine archeological sites were identified within a one-mile buffer of initial array NED and NER alternatives, including one historic site ("Arcade Theater") listed on the National Register of Historic Places (NRHP) and six potentially eligible prehistoric sites. Twelve historic properties listed on the NRHP have been identified within the one-mile buffer, including the Charpentier (Lake Charles) Historic District, as well as four eligible standing structures. Hundreds of standing structures in the area have a minimum age of 50 years and have not been assessed for eligibility.

2.3 Study Authorizations

2.3.1 NED Plan Authorization

This SWC study builds upon prior reports and plans. Area problems and opportunities are documented in these reports. The development of a NED plan was authorized by a Resolution of the Committee on Transportation and Infrastructure, U.S. House of Representatives, Docket 2747, on December 7, 2005, which included consideration of a plan for an armored 12-foot levee along the GIWW across Calcasieu, Cameron, and Vermilion Parishes

The New Orleans District (CEMVN) initiated that Section 905(b) reconnaissance study in April 2006. NED alternatives to mitigate for hurricane-induced damages within Calcasieu, Cameron, and Vermilion Parishes were formulated through a series of planning meetings with the State of Louisiana, local parishes, and other stakeholders. Structural, nonstructural, and coastal restoration measures were considered; however, the economic analysis focused on NED

benefits only. The following three structural alternatives were determined to be economically justified with benefit-cost ratios greater than 1.0:

- Armored 12-foot earthen levee that allows for overtopping constructed along the GIWW alignment on the south side across Calcasieu, Cameron, and Vermilion parishes (height and alignment specified in authorization legislation), with control structures constructed across waterways.
- Non-armored 12-foot earthen levee that allows for overtopping constructed along the north side of the GIWW providing storm damage risk reduction to the Lake Charles area.
- Non-armored 12-foot earthen levee that allows for overtopping constructed along the north side of the GIWW providing storm damage risk reduction to the Abbeville area.

The 905(b) reconnaissance study found sufficient Federal interest to conduct a feasibility study and was approved to advance to the feasibility phase in 2007.

2.3.2 NER Plan Authorization

The investigation of large scale ecosystem restoration concepts, including the Chenier Plain Freshwater Management and Allocation Reassessment Study (Chenier Plain Study), was recommended in the January 31, 2005 Chief's Report for the Louisiana Coastal Area (LCA), Ecosystem Restoration program. The Chenier Plain Study was one of six large-scale restoration concepts that were purported to have the ability to "significantly restore environmental conditions that existed prior to large-scale alteration of the natural ecosystem" upon construction. The LCA program was authorized in Title VII of the Water Resources Development Act of 2007 (WRDA 2007). Guidance provided by the Director of Civil Works on December 19, 2008 states that "*the coastal restoration components proposed as part of the LCA Chenier Plain study will be evaluated as part of the Southwest Coastal Louisiana feasibility study".*

A Feasibility Cost Share Agreement between USACE and the Coastal Protection and Restoration Authority of Louisiana, now known as the Coastal Protection and Restoration Authority Board of Louisiana, ("CPRAB"), as the non-Federal Sponsor was executed on January 14, 2009 for the study and analysis of the NED and NER Plan alternatives.

2.3.3 Prior Studies

Table 2-1 lists relevant reports and studies that were considered in the development of the NED and NER plans.

Table 2-1: Relevant prior studies, reports, programs, and water projects for the SWC Louisiana feasibility study.

Prior Studies, Reports, Programs, and Water Projects	Parish	Potential Data Source	Consistency	Source of Measures
Planning Studies				
Coast 2050 Plan, 1999	All	✓	✓	
Louisiana Coastal Area (LCA), Louisiana Ecosystem Restoration Study, 2004	All	✓	✓	✓
Louisiana's Comprehensive Master Plan for a Sustainable Coast,-2012	All	✓	✓	✓
Louisiana Coastal Protection and Restoration (LACPR) Technical	All	✓	✓	✓

Prior Studies, Reports, Programs, and Water Projects	Parish	Potential Data Source	Consistency	Source of Measures
Report, 2009				
Calcasieu River Basin Feasibility Study (Draft)	Calcasieu	✓		
Calcasieu River and Pass, Louisiana, Dredged Material Management Plan and Supplemental EIS	Calcasieu, Cameron	✓	✓	✓
Federal Laws and Programs				
Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), 1990	All	✓	✓	✓
USACE Continuing Authorities Program (WRDA Sec. 204), 1996	All			✓
Coastal Impact Assistance Program (CIAP), 2001 & 2005	All	✓		✓
Second Emergency Supplemental Appropriations Act to Meet the Immediate Needs Arising from the Consequences of Hurricane Katrina, 2005 (Public Law 109-062)	N/A	✓	✓	
Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic Influenza Act, 2006 (Public Law 109-148)	N/A	✓	✓	
State Laws and Programs				
Louisiana Coastal Wetlands Conservation, Restoration and Management Act, 1989	All		✓	
Act 8 of the Louisiana Legislature First Extraordinary Session of 2005	All	✓	✓	
Parish Coastal Wetlands Restoration Program (Christmas Tree Program)	All	✓		
Vegetation Planting Program	All	✓		
Ecosystem Restoration Projects By Funding Source				
CWPPRA Projects	All	✓	✓	
CIAP Projects	All	✓	✓	
State Projects	All	✓	✓	
WRDA Section 204/1135 Projects	All	✓	✓	
Federal Emergency Management Agency Projects	All	✓	✓	
Federal Navigation Projects				
Bayou Teche and Vermilion River	Vermilion		✓	
Freshwater Bayou and Freshwater Bayou Lock	Vermilion	✓	✓	
Gulf Intracoastal Waterway (GIWW)	All	✓	✓	
Calcasieu River, Pass and Bar Channel	Calcasieu, Cameron	✓	✓	
Mermentau River	Cameron	✓	✓	
Sabine-Neches Waterway	Calcasieu, Cameron	✓	✓	

2.3.4 NED Alternative Formulation

A broader description of the process used to formulate the initial array is captured in Table C-3 in Appendix C. Early modeling was performed to determine where flood damage potential exists in the study area. Figure 2-1 depicts red dots that represent structures within the structure inventory that are at risk of hurricane or storm-induced flood damages. At-risk structures are concentrated in several areas where levee systems could potentially reduce risk. The remainder of the study area (outside of Lake Charles, Delcambre, Abbeville, and Erath) is less densely

populated and at-risk structures are dispersed over large areas. Therefore, nonstructural measures were considered for these less populated areas.

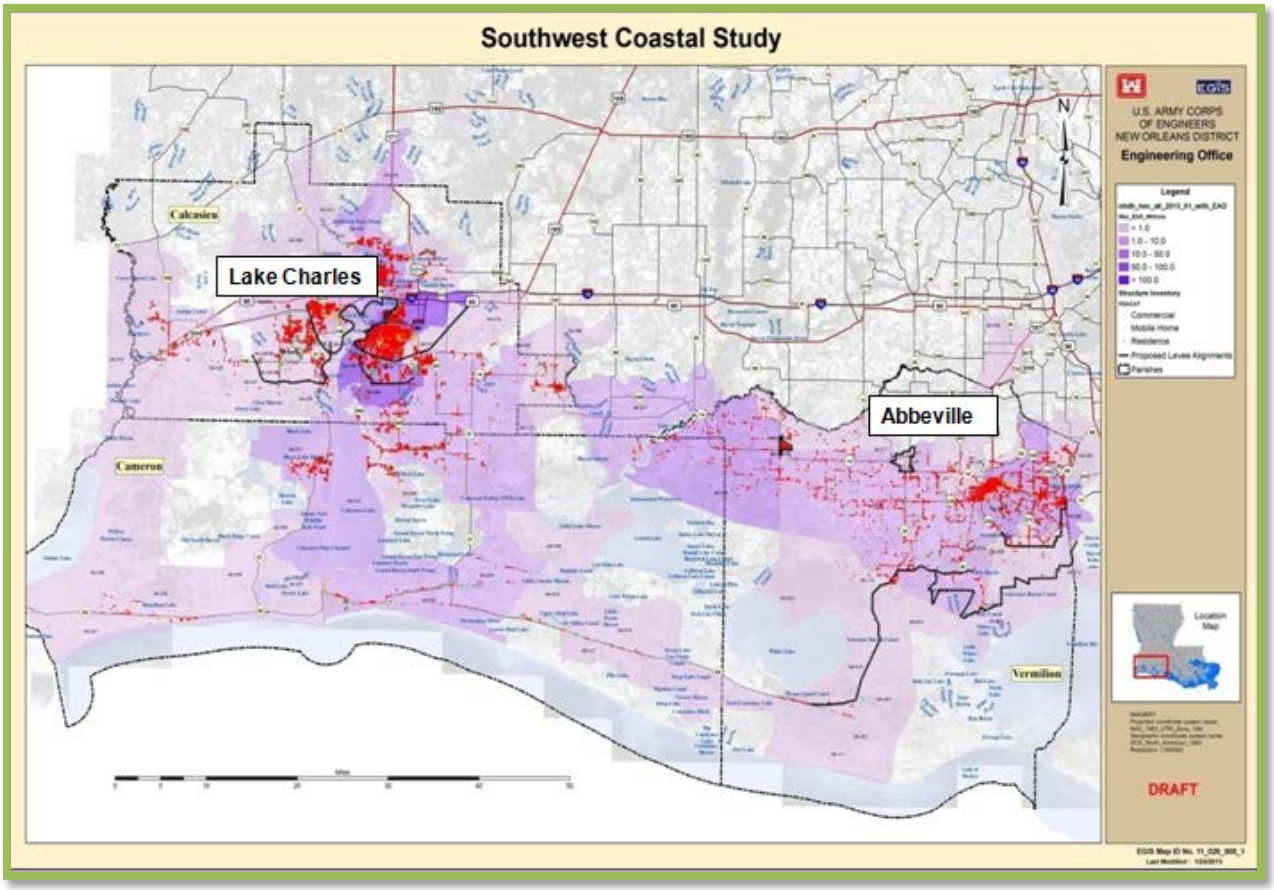


Figure 2-1: Structure inventory and density.

Plan Development Strategies. Prior to developing specific measures and features for alternative formulation, the PDT identified two broad categories to address study goals: a comprehensive levee plan and a comprehensive nonstructural plan. The reconnaissance report recommendation (12-foot levee along the GIWW) was also used as a starting point to achieve study objectives.

- **Armored 12-foot levee along the GIWW (Reconnaissance Report Recommendation).** Study authority requires assessing the "feasibility of constructing an armored 12-foot levee along the Gulf Intracoastal Waterway." This 122-mile levee was determined to be marginally justified in the 2007 reconnaissance report. Nonstructural measures would be applied to communities south of the GIWW, including Cameron, Hackberry, Holly Beach, Creole, Grand Chenier, Pecan Island, and Intracoastal City. This plan is not included in the 2012 State of Louisiana Comprehensive Master Plan for a Sustainable Coast (State Master Plan).
- **Comprehensive Levee Plan.** Individual levees would be built around the largest population centers, and nonstructural measures would be applied in all other areas. Levees could be located around the areas of Lake Charles, Abbeville (including Erath and Delcambre), Kaplan, and Gueydan. The Lake Charles metropolitan area is the largest urban center with a population of approximately 194,000 (U.S. Census, 2009). From west to east, the communities of Gueydan, Kaplan, Abbeville, Erath, and Delcambre are located in northern Vermilion Parish along Highway 14 and have estimated populations of 1,600, 5,200, 12,300, 2,200, and 2,200, respectively (U.S. Census, 2010). The State Master Plan includes plans

for levees in the greater Lake Charles and Abbeville areas. Plans for levees around Kaplan and Gueydan are included in the LACPR study.

- **Comprehensive Nonstructural Plan.** Nonstructural measures were considered as alternatives that could be implemented in the entire study area and were proposed to address individual hydrologic reaches. Owners of eligible residential and commercial structures (including public buildings but excluding warehouses and industrial facilities) would have the option to voluntarily participate in activities such as structure elevating, flood proofing, buy-outs, barriers, and programs such as evacuation plans and public information campaigns.

2.3.4.1 NED Measures (*NEPA Required)

Ten NED measures were developed from various sources including the PDT and the State Master Plan.

Table 2-2: Potential NED measures.

Structural Measures	Nonstructural Measures
Earthen Levees	Structure Raising
Floodgates	Property Buyouts & Building Relocations
Floodwalls	Dry Flood Proofing Methods & Barriers (i.e., small ring levees, berms)
Pumps	Floodplain Management Evacuation Plans
Highway Armoring	Public Information Campaigns, local government building and zoning code requirements, developmental controls, restrictive covenants, etc.

Structural and nonstructural measures were combined to form comprehensive risk reduction plans for the entire study area. North of the GIWW, combinations of structural and nonstructural measures were based on existing plans (i.e., Southwest Coastal Reconnaissance Study, LACPR, State Master Plan, and the Vermilion Parish Hurricane Protection Plan). South of the GIWW, structural plans were not economically justified because of the smaller, dispersed (rural) populations.

2.3.5 Initial Array of NED Alternatives (*NEPA Required)

The following 15 hurricane and storm damage risk reduction alternatives were identified for further analysis:

Table 2-3: NED initial array of alternatives.

Independent Variations	
Armored 12-Foot Levee Along the Length of the GIWW	
Gueydan Ring Levee	
Kaplan Ring Levee	
Louisiana Highway 333/82 Armoring	
Nonstructural Program	
Lake Charles Levee Variations	**Abbeville Levee Variations**
Lake Charles – Southern (east and west)	Abbeville Marsh/Upland Interface
Lake Charles – Southern/Eastern only	Abbeville along GIWW
Lake Charles – Southern/Western only	Abbeville along LA Highway 330
Lake Charles – Northern (east and west)	Abbeville (shortened variation) – Excludes Erath and Delcambre
Lake Charles – Northern (east only)	

Lake Charles – Northern (west only)	

The PDT used the following assumptions to create a screening process for the initial array of NED alternatives.

- Ninety hydrologic reaches characterized by unique relationships between storm surge elevations and frequencies were identified.
- An inventory of structure values, types, and first floor elevations was compiled for all structures in the 90 reaches which showed approximately of 52,000 structures within the SWC area flood zone. Industrial structures and warehouses were not considered due to their disproportionately high economic value.
- A range of low and high costs were developed for the structural features considered.
- Without-action damage estimates were developed and multiplied by a rule of thumb based on the reciprocal of interest and amortization (in this case 20) and used as a surrogate for potential benefits. These values were then used to determine the level of construction costs that could be supported. Stage-probability curves were calculated using HEC-RAS (for rainfall) and ADCIRC (surge) model results. They represent 2012 existing conditions.
- The difference between the benefits and costs represents net benefits.
- Simplifying assumptions were made:
  - No induced damages from flooding outside levees. No damages from waves.
  - No future development or emergency costs.
  - No surge or rainfall damages for events between 25 and 200 years. Net benefits less than zero were used to screen alignments.
- Intermediate Relative Sea Level Rise (RSLR) was used for future conditions.

2.3.5.1 Initial NED Alternative Screening Considerations

Results of how the initial NED alternatives were assessed and eliminated are presented in the Table 2-4. The complete set of structural plans evaluated at this level of screening is described in Table C-4 of Appendix C.

Table 2-4: NED initial screening.

Feature Name (ID)	Levee Length (miles)	Best Estimate Benefits x 20 in mil $[1]	"Low Cost Scenario" Levee + Pumps in mil $[2, 3]	"High Cost Scenario" Levee + Pumps in mil $[4]	Are best estimate benefits x 20 greater than "Low" costs?	Are best estimate benefits x 20 greater than "High" costs?	Screening Decision
Armored 12-ft Levee along the GIWW (per study authority and Recon Alt S-1)	122	1,835	3,372	4,714	No	No	Eliminated; not enough benefits (once repetitive damages removed) to justify structural solution cost.
Gueydan Ring Levee	6	8	120	180	No	No	Eliminated; damages would have to increase by orders of magnitude to justify structural solution cost.
Kaplan Ring Levee	11	0.7	215	325	No	No	Eliminated; damages would have to increase by orders of magnitude to justify structural solution cost.

Louisiana Highway 333/82 Armoring	29	N/A	551	841	N/A	N/A	Eliminated; not enough damages to justify structural solution cost
Abbeville Levee along the Marsh/Upland Interface	33	441	990	1,320	No	No	Eliminated; not enough damages to justify structural solution cost[5]
Abbeville Levee along Highway 330	13	336	275	405	Yes	No	Although benefits are less than high cost estimates, they are within a margin of error. Consider further for reformulation.

1: Multiplication by "20" represents the amortization factor over 50 years based on existing and future-without project expected annual flood damage (EAD). First screening used unadjusted inventory; rainfall, and frequent and repetitive damages were not removed. Damages didn't account for industrial structures or future RSLR. Second screening refined the damages to eliminate frequent, repetitive damages. Based on the results from the Morganza to the Gulf of Mexico study, adjustment for RSLR estimated that damages would increase by 50% over existing damages.
2: "Low" levee cost used $21,000,000/mile armored and $19,000,000/mile unarmored (grass only). The unarmored cost is based on indexing the LACPR estimates to current levels. Assuming the existing ground elevation is +5-feet, a 12-foot levee elevation equals +17-feet; with contingency, the cost per mile would be about $15,500,000 for the levee only. It would be around $18,600,000 including engineering and design, and supervision and administration (rounded to $19,000,000 per mile). Additional cost of $2,000,000 per mile for armoring.
3: Pumping costs for the alternatives based on what was developed for LACPR. Pumping costs for GIWW alignment based on the sum of the largest Lake Charles and Abbeville ring levees.
Other studies: Morganza 35-yr levees cost over $60,000,000 per mile for 10- to 20-ft levees (total cost including structures, mitigation, E&D, S&A, etc). Morganza to the Gulf of Mexico 100-yr levees costs over $100,000,000 per mile for 15- to 26.5-ft levees (total cost including structures, mitigation, E&D, S&A, etc.). Southwest Coastal Reconnaissance Study used $14,000,000 to $20,000,000 per mile but these values were considered extremely low. After initial screening, 10 hurricane and storm surge damage reduction alternatives remained.
4: "High" levee cost used $32,000,000 per mile armored; $29,000,000 per mile un-armored (grass only). High costs based on 50% increase over Low costs rounded up to nearest million.
5: Although this particular alternative was screened, its value as a set of smaller individual levees was evaluated for Abbeville and Delcambre. The incrementalized alternatives were made a part of the focused array.

The screening removed all alternatives with net benefits of less than zero including the following:

- **Armored 12-foot levee along the GIWW:** Screened out because potential benefits do not justify estimated costs.
- **Kaplan and Gueydan ring levees:** Benefits were an order of magnitude less than the costs and as a result only nonstructural measures were evaluated.
- **Louisiana Highway 333/82 armoring:** Since NED benefits are unclear and the highway is maintained by the Louisiana Department of Transportation and Development, it may be more cost effective for the State to construct this measure.
- **Abbeville Levee along the Marsh/Upland Interface:** Screened out because potential benefits do not justify estimated costs.

2.3.6 Focused Array of NED Alternatives (*NEPA Required)

The initial screening left 10 alternatives that constituted the initial focused array that warranted additional evaluation. A full description of all features and screening is available in Appendix C.

Table 2-5: Initial alternatives that comprise the NED Focused Array

Independent Variations
Nonstructural Program
Abbeville Levee Variations
Abbeville along GIWW
Abbeville along LA Hwy 330
Abbeville (shortened variation) – Excludes Erath and Delcambre
Lake Charles Levee Variations
Lake Charles – Southern (east and west)
Lake Charles – Southern/Eastern only
Lake Charles – Southern/Western only
Lake Charles – Northern (east and west)
Lake Charles – Northern (east only)
Lake Charles – Northern (west only)

2.3.7 Evaluation of the Focused Array

The PDT continued assessing the focused array of alternatives which resulted in some levee alignments being incrementalized and developed into new alternatives that warranted further investigation. Although some Abbeville structural alternatives have little to zero marginal benefits, the PDT considered whether a set of smaller individual levees for Abbeville and Delcambre could provide a more cost-effective solution. Since levees around rural areas tend to drive down benefits significantly, the PDT developed smaller, incrementalized alternatives that showed the potential for higher benefits and lower costs that were focused on the more densely populated areas. Additionally, since a structural solution for Abbeville is included in the State Master Plan, new configurations of the Abbeville levee were developed for additional analysis.

Benefits for the east Lake Charles levees outweigh costs, but for the western Lake Charles levees, costs outweigh benefits. As a combined set of structural features, the east and west Lake Charles levees only had marginal benefits to justify costs, but since the PDT felt new levee alignments could be drawn to better focus on more densely populated areas and since a 500-year structural solution for Lake Charles is included in the State Master Plan, reconfigured Lake Charles west levees were carried forward.

These steps allowed the PDT to identify levee alignments that would more precisely target populated areas adjacent to Lake Charles and Abbeville because only the largest population centers had the benefit-cost ratio potential to support structural measures. Three alignments were drawn at a small scale, using existing USACE maps and Google Maps, which protected major residential neighborhoods, while minimizing crossings that would result in major real estate, relocation, and other expenses such as pipelines, major roadways, and industrial areas. The alignments depicted in the graphics below comprise the focused array (along with no action and the nonstructural plan) and were carried forward for additional analysis. Figures 2-2, 2-3, and 2-4 show the locations of the proposed alignments with respect to Lake Charles, Abbeville, Delcambre, and Erath.

The focused array thus consists of the alternative plans listed below. Each structural plan was evaluated at three levels of risk reduction (50-year, 100-year, 200-year levels) along the same alignment during these comparisons.

Plan 0: No Action
Plan 1: Lake Charles Eastbank Levee
Plan 2: Lake Charles Westbank/Sulphur Extended Levee

Plan 3: Lake Charles Westbank/Sulphur South Levee
Plan 4: Delcambre/Erath Levee
Plan 5: Abbeville Levee
Plan 6: Abbeville to Delcambre Levee
Plan 7: Nonstructural Plan

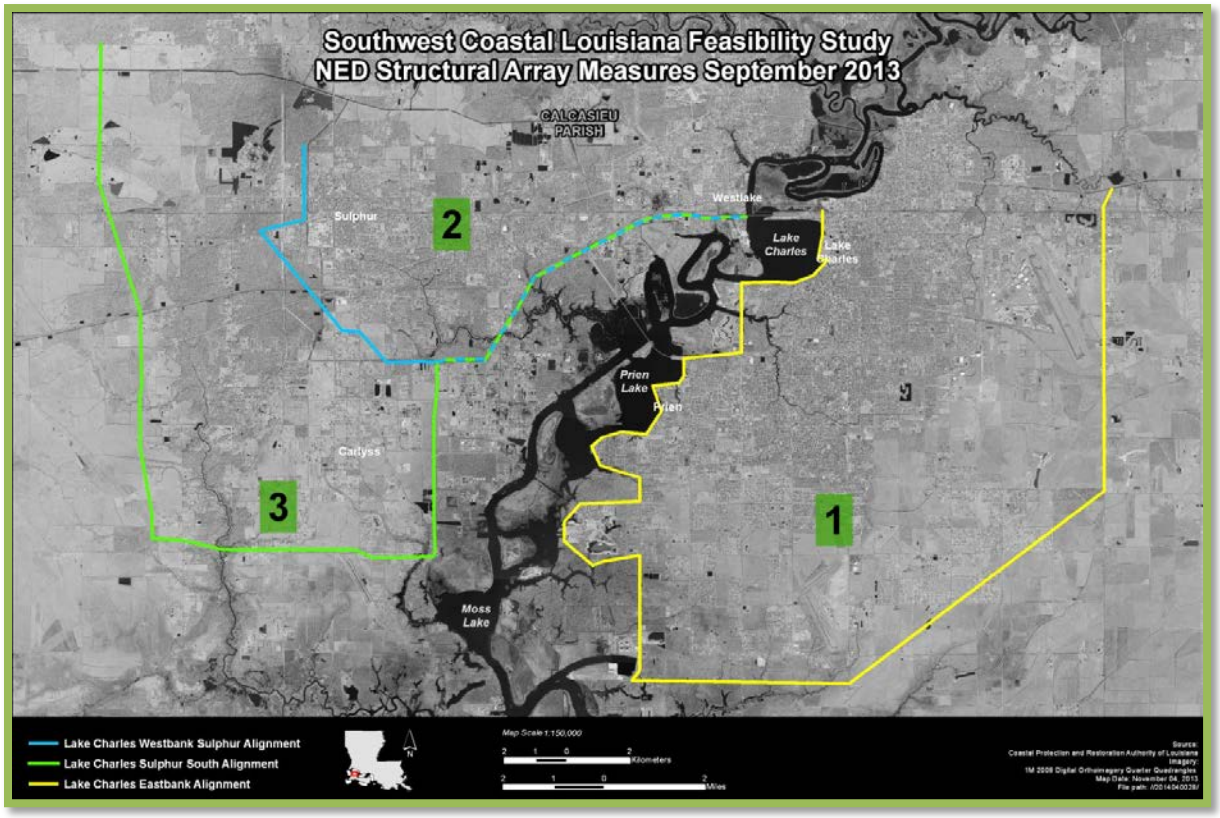


Figure 2-2: Lake Charles conceptual structural alignments.

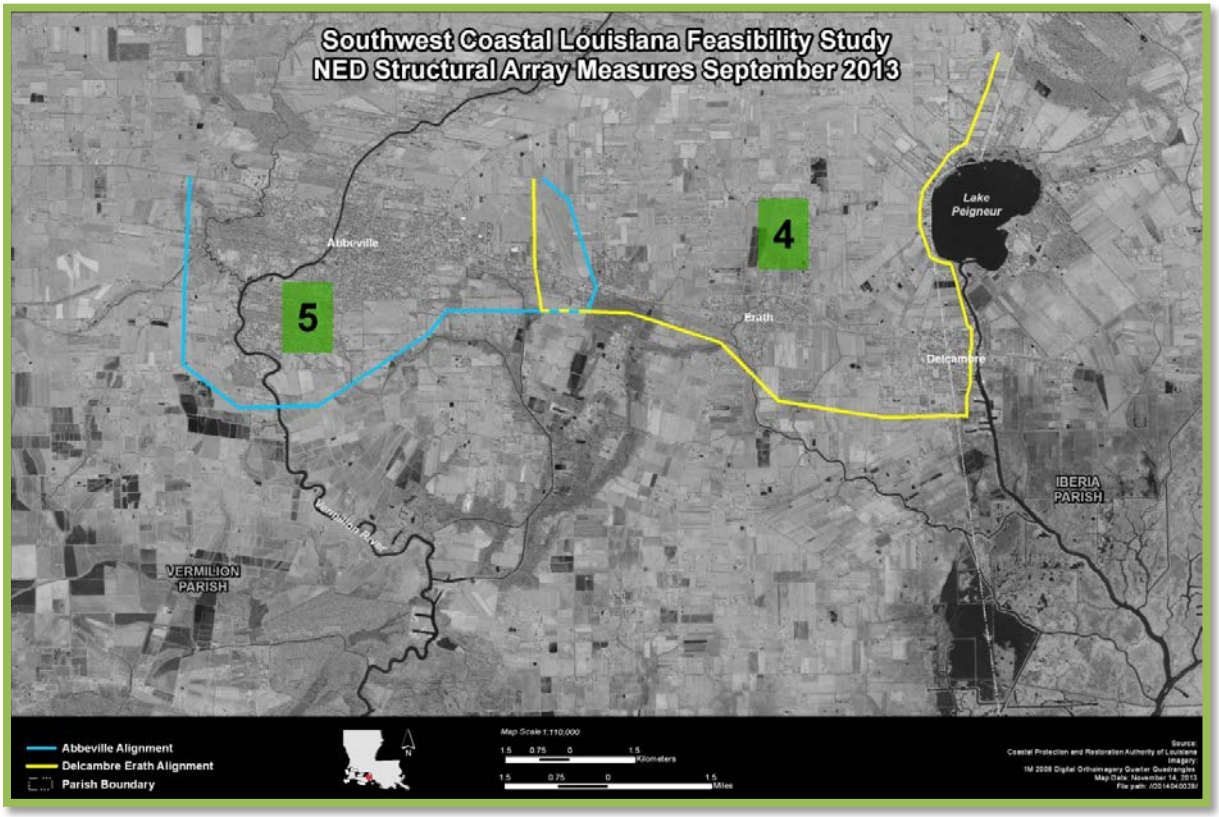


Figure 2-3: Abbeville, Delcambre, and Erath conceptual structural alignments.

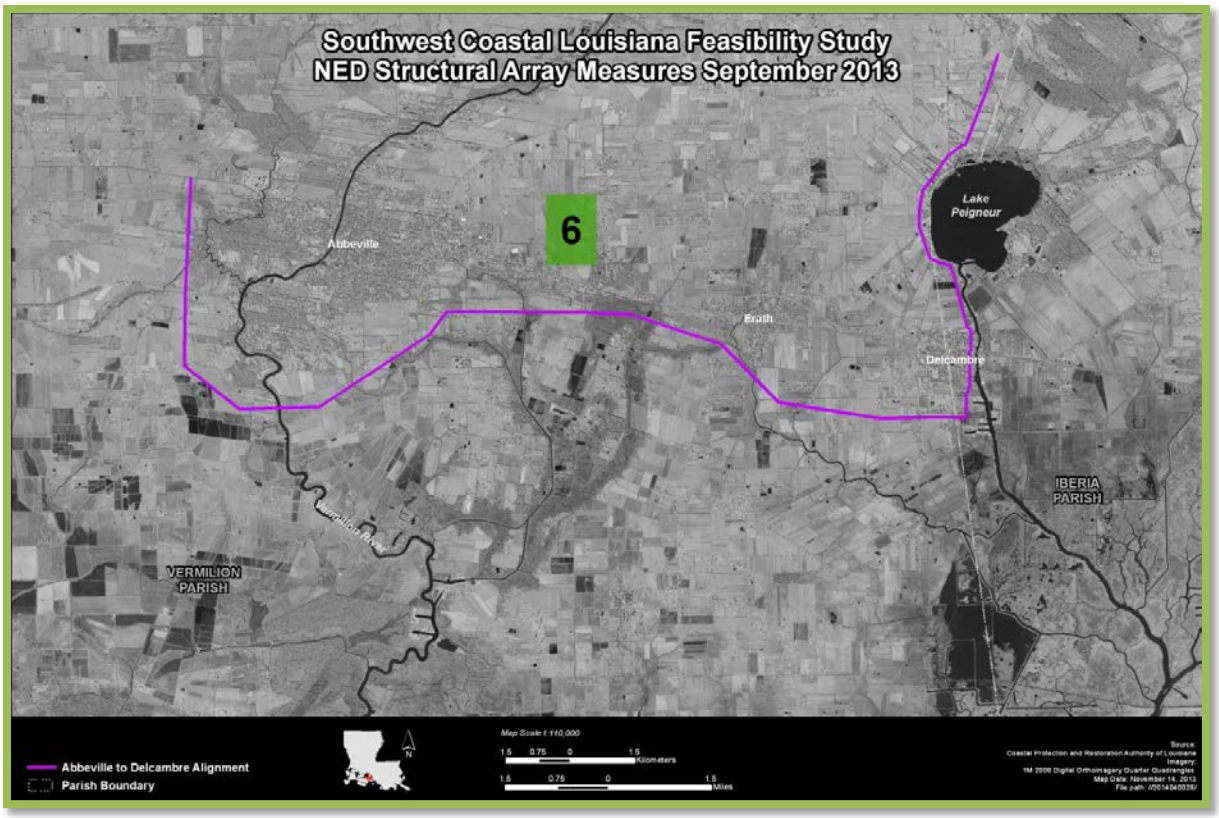


Figure 2-4: Abbeville to Delcambre combined conceptual structural alignment.

2.3.7.1 Structural Evaluation

The ninety hydrologic reaches throughout the study area were developed and characterized by unique relationships between storm surge elevations and frequency. With-project damages were developed for the base and future conditions utilizing existing data, current and future without-project damages, and parametric costs. The alternatives were screened based on the 2 percent, 1 percent and 0.5 percent (50 year, 100 year, and 200 year) levels of risk reduction.

Using the damage probability relationship from the HEC-FDA model for the six structural alternatives in the reaches receiving damage, it was estimated that a 2 percent (50 year) project would eliminate damages for the 25 and 50 year events. The 1 percent (100 year) project would eliminate damages for the 25, 50 and 100 year events and the 0.5 percent (200 year) project would eliminate damages for the 25, 50, 100 and 200 year events. The six alternatives would not eliminate damages from rainfall for more frequent events (1 and 10 year events).

A percentage was applied to the overall benefits by reach for each of the six structural alternatives to reflect the estimated percentage of the total structures in a reach that are receiving risk reduction from each alternative. For example, approximately 40 percent of the residential and non-residential structures in reach XA-305 lie behind the proposed levee alignment. Therefore, the estimated total benefits calculated for that reach are multiplied by 40 percent to determine the benefits for the Abbeville to Delcambre alternative for reach XA-305. This methodology was applied to all proposed alternatives.

2.3.7.2 Economic analysis of NED structural alternatives

A comparison of the NED structural alternatives used a benefit-cost analysis. Expected annual benefits for 2025 and 2075 were converted to an equivalent annual value using the current interest rate, 3.5 percent, and a 50-year period of analysis. Total cost and estimated annual costs for the project alternatives included the construction costs, and operation and maintenance costs for the three levels of risk reduction. Construction costs, along with the schedule of expenditures, were used to determine the interest during construction and gross investment cost at the end of the installation period. For the purposes of this study, construction was assumed to begin in 2017 and continue through 2024 with additional levee lifts beginning in 2067 and construction ending six to seven years later. The first levee lifts would be overbuilt and allowed to settle for several years before the latter levee lift is added for each alternative. Later levee lifts would account for the relative sea level rise and subsidence that is projected to occur throughout the period of analysis.

Tables 2-6 through 2-8 show the first construction costs; average annual costs, average annual benefits; benefit-cost ratios; and net benefits for each alternative in the focused array. As shown in the tables, the Lake Charles Eastbank alternative was the only one with a justified benefit-cost ratio (value >1.0). The Lake Charles Eastbank alternative was justified at each level of protection. The highest net benefits were for the Lake Charles Eastbank alternative at the 100 year level of protection.

Table 2-6: Economic analysis of alternatives with the 50-year level of risk reduction.

Alternatives	First Costs (in Mil $)	Average Annual Costs (in Mil $)	Average Annual Benefits (in Mil $)	Benefit-Cost Ratio	Net Benefits (in Mil $)
Plan 1: Lake Charles Eastbank*	779.4	35.8	37.6	1.05	1.9
Plan 2: Lake Charles Westbank - Sulphur Extended	142.8	6.5	1.4	0.22	-5.0

Plan 3: Lake Charles Westbank - Sulphur South	456.3	20.7	3.0	0.14	-17.7
Plan 4: Delcambre/Erath	359.4	15.5	11.1	0.72	-4.4
Plan 5: Abbeville	286.0	12.9	2.6	0.20	-10.3
Plan 6: Abbeville to Delcambre	628.5	27.8	19.4	0.70	-8.4

Table 2-7: Economic analysis of alternatives with the 100-year level of risk reduction.

Alternatives	First Costs (Mil $)	Average Annual Costs (Mil $)	Average Annual Benefits (Mil $)	Benefit-Cost Ratio	Net Benefits (Mil $)
Plan 1: Lake Charles Eastbank*	979.1	43.9	50.7	1.16	6.8
Plan 2: Lake Charles Westbank Sulphur Extended	199.3	8.6	3.3	0.39	-5.2
Plan 3: Lake Charles Westbank Sulphur South	629.1	27.6	7.2	0.26	-20.4
Plan 4: Delcambre/Erath	470.8	20.3	14.5	0.72	-5.8
Plan 5: Abbeville	344.1	15.4	7.2	0.47	-8.2
Plan 6: Abbeville to Delcambre	784.2	34.4	27.1	0.79	-7.3

Table 2-8: Economic analysis of alternatives with the 200-year level of risk reduction.

Alternatives	First Costs (Mil $)	Average Annual Costs (Mil $)	Average Annual Benefits (Mil $)	Benefit-Cost Ratio	Net Benefits (Mil $)
Plan 1: Lake Charles Eastbank*	1,224.1	54.2	61.1	1.13	6.9
Plan 2: Lake Charles Westbank Sulphur Extended	327.1	13.9	5.5	0.39	-8.4
Plan 3: Lake Charles Westbank Sulphur South	883.9	38	12.5	0.33	-25.5
Plan 4: Delcambre/Erath	589.5	25.4	17	0.67	-8.5
Plan 5: Abbeville	447.7	19.9	9.7	0.49	-10.2
Plan 6: Abbeville to Delcambre	1,000	43.6	32.5	0.75	-11.1

** Although preliminary assessments identified a positive benefit-cost ratio for this alignment, further analysis described in section 2.3.8 revealed a negative benefit-cost ratio.*

2.3.7.3 Nonstructural Alternative

A variety of nonstructural actions were evaluated such as:

- Elevation of eligible (residential) structures up to a maximum 13 feet (the year 2075 base flood elevation or BFE) in place. Means of elevation can be use of pilings, cinder block chain walls, dirt/fill material, and other methods.
- Acquisition/buyout of eligible residential structures that would require raising over 13 feet (and underlying land). Structures would be demolished, property evacuated, and property owners relocated to another site outside of the 100 year floodplain. Property owners would receive fair market value for the property acquired.
- Physical relocation (lifting and moving) structures (i.e., historic structures) to another location outside of the 100 year floodplain.
- Construction of small floodwalls, ring levees, and berms (3-7 feet high) are constructed and located away from the structure(s) to be protected to prevent the encroachment of floodwaters.
- Dry flood proofing of eligible commercial and public structures (excluding industrial buildings and warehouses) for flood depths not greater than three feet above the adjacent ground by methods such as sealing the walls of structures with waterproofing compounds, impermeable sheeting (veneer walls) and other materials and covers to protect openings from floodwaters. Note: Warehouses are large structures that store or distribute their contents and industrial facilities are large buildings that contain heavy equipment (wet flood proofing was not considered during this study phase).
- Evacuation plans, public information campaigns, local building and zoning code amendments and restrictions, developmental controls, restrictive covenants, deed restrictions, and other similar actions.

A review of the benefit-cost analysis of nonstructural reaches was performed. Economic justification of each reach was determined by a comparison of average annual benefits to average annual costs. Reaches with a benefit-cost ratio greater than 1.0 were carried forward for additional consideration. Justification was determined by comparing expected annual benefits to expected annual costs. Net benefits were calculated by subtracting expected annual costs from expected annual benefits. The analysis found 11 of 90 reaches were economically justified as shown in Figure 2-5. Table 2-9 identifies costs, benefits, and benefit-cost ratios for each of the justified reaches. The data extracted from the justified reaches demonstrates the Federal interest in a nonstructural plan and provides definition of the potential magnitude of the plan.

Additional Nonstructural Evaluation

The total number of structures in the entire study area (2,000 year floodplain) inventory is 52,000 (total structure inventory). Of the total structure inventory, the number of at-risk structures in the 100-year floodplain totaled 26,604 residential, commercial, and public buildings (but excluding warehouses and industrial buildings) with a FFE below the 100 year stage. Nonstructural plans were evaluated using the 90 hydrologic reaches that comprise the study area as the unit of analysis. As a result, benefits and costs were calculated on a reach-by-reach basis. This preliminary analysis provided the necessary data to develop programmatic nonstructural plans.

The total expected annual benefits for addressing all the structures 26,604 within the 100-year floodplain are $74.6 million. The total cost for implementing the nonstructural alternative throughout the 100-year floodplain is approximately $3.2 billion. The corresponding average annual cost is approximately $138.2 million. After evaluating the entire 90 reach study area, which hereafter is referred to as the Nonstructural 100 Year Floodplain plan or Plan 8, it was determined that the benefit-cost ratio for addressing all structures within the 100-year floodplain

was 0.54. This assessment resulted in the PDT referring to the 100-year floodplain nonstructural plan as Plan 8.

Further, the analysis found that 11 of the 90 hydrologic reaches had a benefit-cost ratio of 1.0 or greater and were economically justified with the ratios for the remaining 79 reaches falling below unity. The combined expected annual benefits for the justified reaches, hereafter referred to as the Nonstructural Justified Reaches (original Plan 7), was estimated at $20.67 million, and assuming 100% property owner participation, the total cost for implementing a nonstructural alternative based solely on the justified reaches is approximately $388 million. The corresponding average annual cost is approximately $16.5 million; with net benefits of $4.17 million resulting in a benefit cost ratio of 1.25.

Additional detail on the full nonstructural analysis can be found in Appendix D.

Table 2-9: Justified nonstructural reaches.

Reach	Total Cost (in Th $)	Number of Structures in Reach	Average Annual Cost (in Th $)	Equivalent Annual Benefits (in Th $)	Benefit-Cost Ratio	Net Benefits (in Th $)
SA-033-RL(76)	8,466	77	361	369	1.01	3
SA-034(79)	9,591	122	409	622	1.51	208
SA-048(106)	34,647	389	1,477	2,022	1.36	532
SA-070-S(139)	13,687	134	583	934	1.59	345
SA-091(187)	12,896	169	550	1,362	2.46	802
SA-112(250)	10,177	148	434	573	1.31	132
XA-306(280)	296,306	2,860	12,632	14,691	1.15	1,958
XA-324(337)	1,232	7	53	66	1.26	13
XA-327(346)	114	1	5	8	1.66	3
XA-336(373)	583	5	25	131	5.22	105
XA-341(388)	341	3	15	36	2.44	21

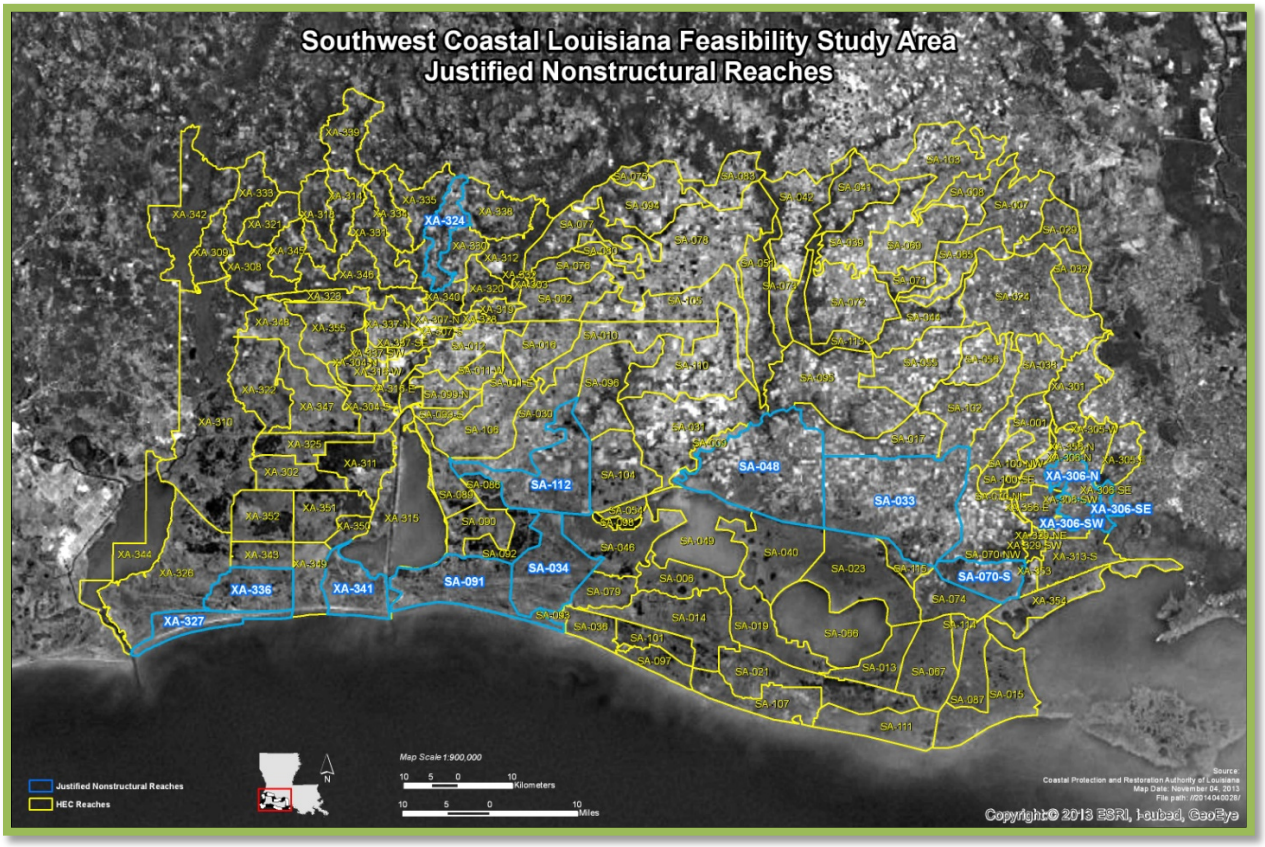


Figure 2-5: Nonstructural reaches with justified benefit-cost ratios.

2.3.8 Net Benefits of the Focused Array

See Table 2-10 for a summary of the net benefits of the structural alternatives in addition to the Nonstructural Plan benefits for the 100-year level of risk reduction. The two nonstructural plans considered any structure with a FFE below the 100 year stage. This was done to correspond with FEMA regulations that require new development to FFE higher than the 100 year floodplain.

Table 2-10: Net NED benefits.

Alternatives	50 year (Mil $)	100 year (Mil $)	200 year (Mil $)
Plan 1: Lake Charles Eastbank	1.9	6.8	6.9
Plan 2: Lake Charles Westbank Sulphur Extended	-5.0	-5.2	-8.4
Plan 3: Lake Charles Westbank Sulphur South	-17.7	-20.4	-25.5
Plan 4: Delcambre/Erath	-4.4	-5.8	-8.5
Plan 5: Abbeville to Delcambre	-8.4	-7.3	-11.1
Plan 6: Abbeville	-10.3	-8.2	-10.2
Plan 7: Nonstructural Plan (Justified Reaches Plan)	N/A	4.3	N/A

Plan 8: Nonstructural Plan (100-year Floodplain Plan)	N/A	-64.3	N/A

Additional Structural Evaluation

The assessment of economic feasibility for six independent structural measures was conducted as part of the focused array analysis. The initial results of the assessment showed that only one structural alternative was economically justified: the Lake Charles Eastbank Levee Alternative. However, at the time of the assessment an estimate of mitigation costs (costs each structural alternative must account for due to unavoidable impacts to wetland habitats) had not been calculated for the Lake Charles Eastbank levee alternative. With mitigation costs of approximately $100,000,000 included for each alternative, the 100-year level of risk reduction yielded a benefit-cost ratio of 1.01 and the 200-year level of risk reduction yielded a benefit-cost ratio of 1.04 (adding the mitigation costs made the 50-year level of risk reduction not economically justified).

Additional assessment of the 100-year and 200-year Lake Charles levee alignments was conducted to evaluate the potential for any other viable levee design scales (75-year, 125-year). As a result of this additional investigation an error was found in the structure inventory database. The structure inventory used to calculate benefits for each alternative was modified to adjust a commercial structure that inadvertently was included in the 100-year flood plain and accounted for an unusually high percentage of damages and benefits in initial evaluations. Once this adjustment was completed, the benefit-cost ratio fell to 0.61 for the 100-year level of risk reduction and to 0.30 for the 200-year level of risk reduction. Ratios this low indicate costs far outweigh benefits and therefore no structural levee alternatives should be carried into the final array.

2.3.9 Final Array of Alternatives

The evaluation of the focused array determined that the most cost-effective solution to reduce hurricane and storm surge flood-risk within the study area is through nonstructural solutions. Two alternative nonstructural plans plus No Action were carried forward for the NED final array. One was Plan 7, Nonstructural Justified Reaches, based on only the 11 economically justified reaches. A second, designated Plan 8, Nonstructural 100-year Floodplain, was considered by the team to represent a potentially reasonable alternative based on the incremental nature of nonstructural measures.

Although 79 of the 90 reaches were identified as not economically justified having a benefit-cost ratio of less than 1.0, significant potential damages were identified within a number of the non-justified reaches indicating the potential for viable additional action through other Federal or local entities or programs.

2.3.10 Identification of the NED Tentatively Selected Plan (TSP)

The identified NED Tentatively Selected Plan is Plan 7 - Nonstructural Justified Reaches. Plans 7 and Plan 8 are, based on the 100-year floodplain alternative and were carried forward. Only Plan 7 was economically justified. The TSP will apply nonstructural solution measures (i.e. structure raising, flood proofing, and property buy-outs) to structures within the 11 justified reaches.

For at-risk properties within the 100-year floodplain in the justified reaches solutions could entail elevation of existing homes and/or businesses, buyouts of properties that require significant elevation, construction of berm features, and/or flood proofing measures for non-residential

structures. The initial basis for the tentative nonstructural plan is the number of structures and cost identified in the 11 justified reaches. The preliminary estimated cost of the NED TSP is $388,000,000 with 3,915 structures affected.

2.4 NER Alternative Formulation

The Louisiana Chenier Plain extends from the western bank of Freshwater Bayou westward to the Louisiana-Texas border in Sabine lake, and from the marsh areas just north of the GIWW south to the Gulf of Mexico in Calcasieu, Cameron, and Vermilion parishes. Coastal erosion in the Chenier Plain accounts for approximately 20 percent of the land loss in Louisiana. The January 31, 2005 Chief's Report for the ecosystem restoration of the LCA discussed reducing wetlands losses by 50 percent as a possible desirable outcome from restoration efforts, including the development of a comprehensive restoration plan for the Chenier Plain ecosystem. Potential features to be analyzed may include modification of existing authorized navigation and flood control projects, dedicated or beneficial use of dredged material, shoreline protection, modifications of land-use practices, and restoration of tidal influence to appropriate areas. The entire study area as identified in Figure 2-6 was considered for NER formulation in terms of system integrity and stability. However, even though a significant portion of the area within the Coastal Zone Management Area has already received funding from other sources for features to address coastal land loss (Figure 2-6), this study does consider overlapping features in those areas.

The NER purpose of the SWC Study is to evaluate coastal restoration components and significantly restore environmental conditions and ecosystem integrity for the Chenier Plain ecosystem as more fully described in the LCA Ecosystem Restoration Study (2004). The principle areas of focus for the LCA plan formulation are the Calcasieu-Sabine Basin located between the GIWW and the Gulf of Mexico, primarily in the vicinity of Calcasieu and Sabine Lake and the Mermentau/Teche-Vermilion Basins between the GIWW and Gulf of Mexico, Vermilion Bay, and LA Highway 27 to the west.

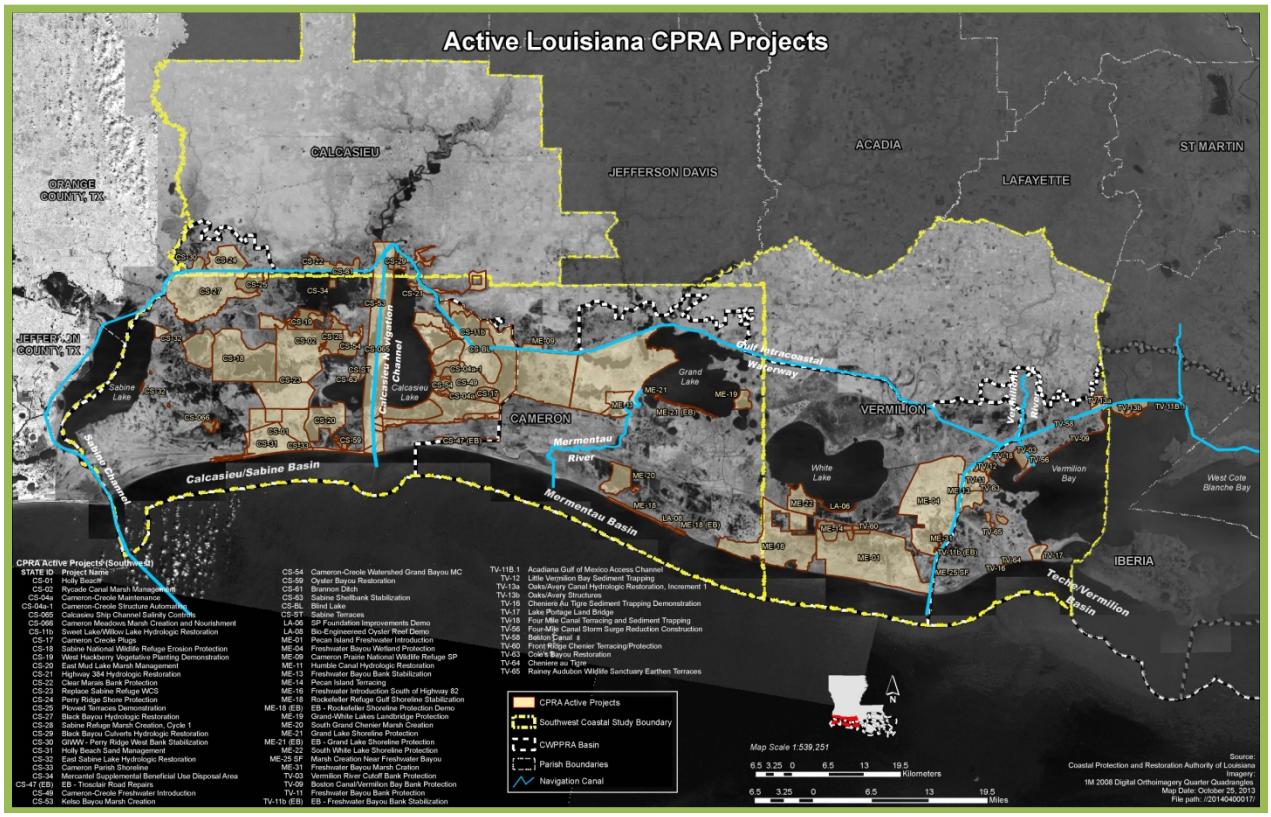


Figure 2-6: Restoration projects in the study area.

A conceptual ecosystem model (Figure 2-7) was developed in conjunction with the USACE Engineering Research and Development Center (ERDC). It identified five drivers, seven ecological stressors, and four ecological effects. The most serious problem is the rate of land and habitat loss.

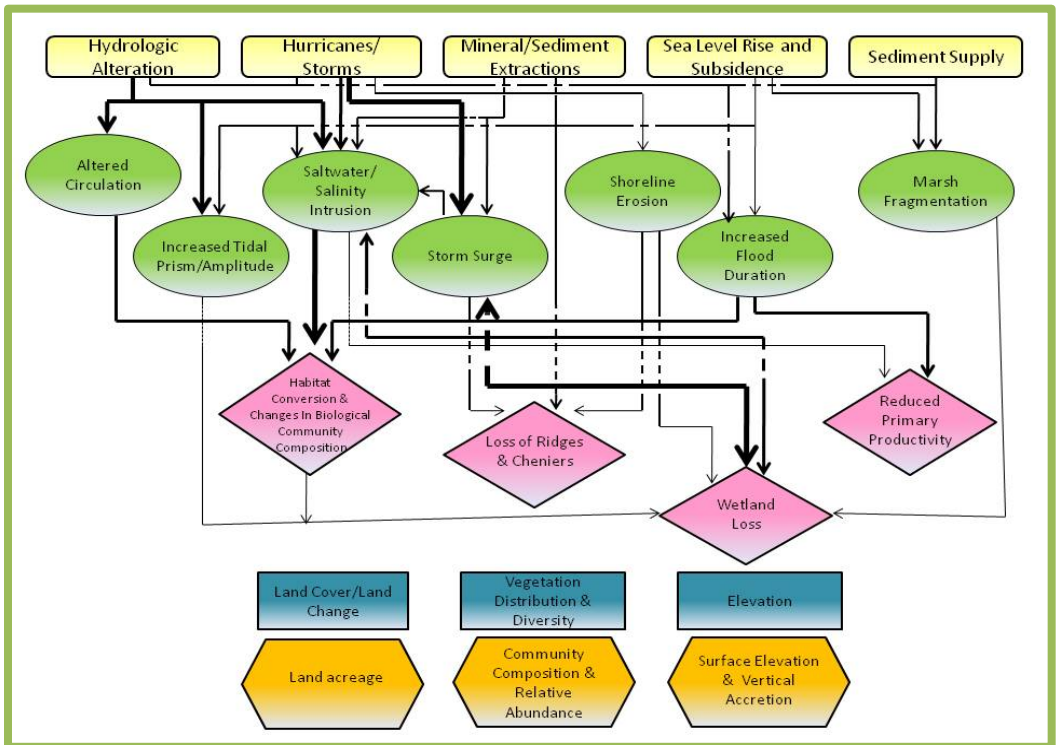


Figure 2-7: Conceptual ecological model.

2.4.1 NER Measures (*NEPA Required)

Restoration of the southwestern Louisiana ecosystem has been within the scope of previous planning studies which the PDT relied upon to identify potential measures and screening criteria. These prior studies included Federal projects authorized or constructed by the CWPPRA program; the USACE Continuing Authorities Program; the LCA Ecosystem Restoration Study (USACE 2004); and the LACPR study (USACE 2009). Additionally, the team relied upon the State Master Plan, and the U.S. Department of Interior's Coastal Impact Assistance Program.

The PDT recommended five measures to meet the NER goals and objectives:

1. **Marsh restoration.** Consists of marsh restoration and/or nourishment to increase land coverage in the area, and improve terrestrial wildlife habitat, hydrology, water quality, and fish nurseries.
2. **Bank and shoreline protection/stabilization.** Protection/stabilization features to reduce the rate of erosion at canal banks and shorelines in critical areas and improve hydrology.
3. **Hydrologic and salinity control structures.** Control structures to manage water flow and minimize saltwater intrusion into marshes.
4. **Chenier reforestation.** To restore native trees to the Chenier ecosystem, and reduce land loss rates and control for invasive species.
5. **Oyster reef preservation** To restore and preserve these native features, and reduce shoreline erosion rates.

2.4.1.1 Initial Screening of NER Measures

Initial data collection included over 200 features which were mostly basin and/or location specific, but some applied to the overall study area. The first screening removed features that did not address project goals and objectives. The marsh restoration and shoreline protection/stabilization features were evaluated with the Wetland Value Assessment (WVA)

model, and compared to costs to evaluate cost-effectiveness. Measures that were not cost-effective were eliminated unless the location served a critical geomorphologic function.

Measures were screened using the following criteria:

- **Constraints and Goals.** Measures that were not expected to be sustainable were eliminated such as marsh restoration measures located in currently open water areas where depth is greater than 2 feet or in high subsidence areas along with Chenier reforestation in locations with elevations less than 5 feet and areas with high shoreline erosion rates.
- **Objectives.** These criteria served as verification of previous screenings, to ensure that the measures being considered for inclusion were applicable to SWC objectives. Each of the measures was found to support the relevant objective. For example marsh restoration measures south of Highway 82 were eliminated because they did not support any critical landscape features.
- **Effectiveness.** There were different thresholds used to identify whether measures were considered to be effective. Hydrologic and salinity controls were eliminated if they did not produce benefits for at least 500 net acres. Marsh restoration measures needed to restore or create at least 100 acres. Oyster reef preservation measures were all considered to be effective measures.
- **Efficiency.** The final criteria compared cost per acre within the measure categories. If two measures produced the same benefits but one was less expensive to construct, the cheaper option was carried forward. For example, the West Cove marsh restoration measures were eliminated because the Mud Lake measure would provide restoration at a cheaper cost.

The results of the NER screening evaluation are presented in Table 2-11.

Table 2-11: NER screening evaluation.

Screening Criteria		Application to Each NER Measure Category				
		Marsh Restoration	**Bank and Shoreline Protection/ Stabilization**	**Chenier Reforestation**	**Hydrologic & Salinity Control**	**Oyster Reef Preservation**
Constraints and Goals	Measure violates one of the study planning constraints or goals.	Features that are not sustainable do not meet the sustainability goal and were eliminated e.g. marsh areas where water depth is > 2 feet or local subsidence is high.	None of the shoreline stabilization features were eliminated.	Features that did not meet the sustainability goal were eliminated. Elevations < 5 ft NAVD 88 and areas exposed to high rates of shoreline erosion were screened.	None of the hydrologic or salinity control features were eliminated.	None of these features were eliminated.

Screening Criteria		Application to Each NER Measure Category				
		Marsh Restoration	Bank and Shoreline Protection/ Stabilization	Chenier Reforestation	Hydrologic & Salinity Control	Oyster Reef Preservation
Objectives	Measure does not address one or more of the study planning objectives.	All marsh restoration measures meet Objective 5. No marsh restoration features were eliminated.	All shoreline protection/stabilization measures meet Objective 4. No shoreline stabilization features were eliminated.	All Chenier reforestation measures meet Objective 5. No Chenier features were eliminated.	All hydrologic and salinity control measures meet Objective 2. No control features were eliminated.	All measures meet Objective 5. No oyster reef preservation features were eliminated.
Effectiveness	Measure found to be ineffective.	Marsh or shoreline protection/stabilization measures producing or protecting less than 100 net acres were considered to be ineffective.		Features were eliminated where existing canopy coverage deemed substantially intact (i.e., >50%) or if the presence of development would prohibit reforestation.	A small number of hydrologic and salinity control features were eliminated as ineffective because they did not exhibit large-scale hydrologic benefits to wetlands in the Chenier Plain.	None of the oyster reef preservation features were eliminated Reef restoration is an effective method of using natural barriers against storm surges and saltwater intrusion.
Efficiency	Measure found to have below average efficiency.	The average cost of all marsh and shoreline features based on the initial evaluation was approximately $125,000/net acre. Features were considered inefficient and eliminated if they had greater than average cost/net acre. Features that are considered critical components of the system were not eliminated Features that are located adjacent to significant resources, such as Cheniers and wildlife refuges were also not eliminated.		All Chenier reforestation features were found to be relatively cost efficient in comparison to each other.	All control features were found to be relatively cost efficient in comparison to each other.	All reef preservation features were found to be relatively cost efficient in comparison to each other.

After the initial screening there were too many potential combinations of features for the PDT to effectively assess and evaluate, therefore, the PDT developed an additional methodology through *plan development strategies* to further screen features and develop an initial array of alternatives.

2.4.2 Initial Array of NER Alternatives (*NEPA Required)

Plan Development Strategies

Five NER measure types with individual features of only each measure type were created. In keeping with the overall study purpose of addressing ecosystem degradation in the entire

Chenier Plain, the PDT also developed one plan integrating all measure types across all basins. Because the coastal zone is the area in greatest need of environmental restoration, all of the five measures types being considered are located south of the GIWW.

- **Hydrologic and Salinity Control.** This plan contains 49 hydrologic and salinity control features.
- **Marsh Restoration.** This plan contains 52 marsh restoration and/or nourishment features.
- **Shoreline Protection/Stabilization**. This plan contains 50 bank and shoreline protection features.
- **Chenier Reforestation**. This plan contains 14 reforestation features (with invasive species control).
- **Oyster Reef Preservation.** This plan contains 10 oyster reef preservation features.
- **Integrated Restoration Across Basins**. This plan contains features from all five measure categories. It contains a variety of basin-specific and study area-wide features.

2.4.2.1 Screening of the Initial Array

An additional screening (outlined below and more fully explained in Figure C-1 and Tables C-9, C-10, and C-11 of Appendix C) of the remaining features prior to incorporation in these plans was also conducted and many features were removed from further consideration. Screening criteria were also developed for the measure types. Land loss analyses were conducted by the U.S. Geological Survey (USGS) to support screening decisions, specifically regarding whether an area is experiencing high land loss and thus is an area of critical need.

Additional screening applied to the remaining features consisted of:

- **Reinforcement of Critical Landscape Features**. Features that were on or adjacent to a landscape feature designated as critical were carried forward.
- **Reinforcement of Critical Infrastructure**. Features that restore wetlands from open water and that protect the continuity and function of critical infrastructure were carried forward.
- **Synergy with Other Projects**. Features that protect or contribute to the benefits of other projects were carried forward.
- **Scarcity/Diversity**. Features that reduce the loss of freshwater marsh, which has the greatest plant diversity of any of the marsh types and is considered imperiled by the Louisiana Natural Heritage Program, were carried forward.
- **Robustness/Sustainability**. Features that are attached to landforms that are expected to persist through the period of analysis were carried forward.
- **Implementability Issues**. Features that have no serious impediment precluding its timely implementation were carried forward.

Features were subjected to more detailed analysis. WVAs were conducted for remaining features using all available data (such as State Master Plan analyses) and assumptions based on professional experience and knowledge. The results of the WVAs were combined with cost estimates to select cost-effective features. The following features were screened (with more information available in Appendix C):

- **Marsh Restoration.** Interior locations with lower salinities were eliminated because it is considered more important to implement marsh restoration in areas experiencing high salinities. Mineral sediment that is introduced with marsh restoration helps mitigate the plant toxins that are associated with higher salinities, thus increasing marsh sustainability.
- **Bank and Shoreline Protection/Stabilization.** A single shoreline protection/stabilization feature, a foreshore rock dike along the toe of the Cameron-Creole levee, was eliminated due to lack of marsh between the proposed rock dike and the levee. Stabilization at this

location did not supply many NER benefits. Because of the lack of NER benefits, this feature was removed from further consideration.

- **Hydrologic and Salinity Control.** A WVA analysis was not completed because the model cannot adequately describe the benefits of these features across such a large area. In general, the features that were carried forward were those that had larger-scale benefits, such as those that helped maintain greater than 500 net acres as determined by the State Master Plan models.
- **Chenier Reforestation.** Although strategic project areas to reforest Cheniers were identified and evaluated, due to the relative affordability of this measure type no specific features were screened. It was decided that all Chenier reforestation features would move forward as part of a consolidated Chenier Reforestation Program.
- **Sabine Lake Oyster Reef Preservation.** Several oyster reef projects were removed from further consideration due to very modest benefits and existing or planned funding through other programs. The PDT determined that a single feature, the Sabine Lake Oyster Reef, should be preserved because its 3-dimensional structure provides valuable habitat for various fisheries species and it also provides some hydrologic benefits to the remainder of Sabine Lake. The feature carried forward consists of protecting, and thus, preserving the Sabine Lake Oyster Reef by prohibiting the harvesting of oysters from the reef.

NER Alternative Evaluation The NER features that were eliminated in the secondary screening reduced the overall size of the initial array of alternatives. The comprehensive effects of these alternatives (including the no action) were estimated using the State Master Plan models (i.e., Wetland Morphology, Eco-Hydrology, Vegetation, and various land loss analysis and hydrodynamic models). The outputs of these models supplied the data required for subsequent analysis using the WVA model. Hydrodynamic modeling using the MIKE FLOOD model was used concurrently to evaluate the restoration alternatives and help refine the features included in the alternatives (specifically the type, size, and operation of the hydrologic and salinity control features).

Results from the additional models indicated that the NER objectives could not be met through the implementation of a single-measure alternative plan and as a result, the single measure plans were eliminated. The Integrated Restoration Across Basins alternative was the only plan capable of meeting the study goals and objectives and was carried forward. In addition, variations of the Integrated Restoration Across Basins alternative were developed in the formulation of the focused array to more thoroughly address study area problems.

2.4.3 Focused Array of NER Alternatives

Using seven focused array strategies developed from the findings from the initial array, plus No Action, the PDT developed a focused array of 27 alternative plans that contained different combinations of the features that were carried forward from the earlier screening. The focused array strategies were applied both comprehensively across basins and individually to the Calcasieu-Sabine Basin and Mermentau/Teche-Vermilion Basin (see Table 2-12). The PDT also determined that a Calcasieu Ship Channel Salinity Control Structure was worth evaluating as a stand-alone strategy/alternative. This alternative was also combinable with other integrated restoration plan alternatives.

The locations of the NER focused array of alternatives are in: (1) the Calcasieu-Sabine Basin located between the GIWW and the Gulf of Mexico, primarily in the vicinity of Calcasieu Lake and (2) the Mermentau/Teche-Vermilion Basins which are primarily clustered south of Grand and White Lakes, and in the area surrounding Freshwater Bayou. For analysis purposes, each plan was divided into two geographic parts. Plans denoted with a “C” contain features located in

the Calcasieu-Sabine Basin. Plans denoted with an "M" contain features located in the Mermentau and Teche-Vermilion Basins. Plans that were derived from the State Master Plan are identified with "SMP". The Calcasieu Ship Channel Salinity Control Structure is the sole component of the seventh strategy and a standalone alternative designated as Plan "A". Plan "A" is also combinable with any plan containing a Calcasieu-Sabine Basin, or "C" component.

Focused Array NER Strategies

Strategy 0: **No Action Plan.**

Strategy 1: **Large Integrated Restoration (SMP).** The results of the State Master Plan Models were used to select only those hydrologic and salinity control features that showed the greatest benefits. For marsh restoration, features were selected that would best reinforce critical landscape features, with particular emphasis on areas that are exposed to saltwater, tidal, and wave action. Bank and shoreline protection/stabilization features were retained that protected the areas of greatest erosion. Strategy 1 is composed of 7 hydrologic and salinity control features, 18 marsh restoration features, 7 bank and shoreline protection/stabilization features, all Chenier reforestation features, and preservation of the Sabine Lake Oyster Reef.

Strategy 2: **Moderate Integrated Restoration (Hydrologic Emphasis) (SMP).** This alternative has less investment in marsh restoration and bank and shoreline protection/stabilization features, but retains the same level of hydrologic and salinity control features as Strategy 1 due to the philosophy that hydrologic restoration is of great importance to the Chenier Plain. Marsh restoration features were focused on areas of critical importance for restoration. Bank and shoreline protection/stabilization features were retained that protected the areas of greatest erosion. Strategy 2 is composed of 7 hydrologic and salinity control features, 13 marsh restoration features, 4 bank and shoreline protection/stabilization features, all Chenier reforestation features, and protection and preservation of the Sabine Lake Oyster Reef.

Strategy 3: **Moderate Integrated Restoration, Including Gum Cove (SMP).** This Strategy is identical to Strategy 2 except for the inclusion of the Gum Cove Lock feature. Strategy 3 was formulated to investigate the hydrologic restoration benefits and cost-effectiveness of the Gum Cove Lock feature in combination with the Calcasieu Ship Channel Salinity Control Structure. Strategy 3 is composed of 8 hydrologic and salinity control features, 13 marsh restoration features, 4 bank and shoreline protection/stabilization features, all Chenier reforestation features, and protection and preservation of the Sabine Lake Oyster Reef.

Strategy 4: **Small Integrated Restoration (SMP).** The focus of Strategy 4 is the control of salinity levels near the Gulf of Mexico entrances of the Calcasieu Shipping Channel and Sabine Pass, and Cameron-Creole Watershed. There are minimal other interior hydrologic and salinity control structures, with the expectation that salinity control near the Gulf of Mexico will result in lower salinities throughout the basins. This Strategy includes those marsh restoration and bank and shoreline protection/stabilization features that could reinforce perimeters. Strategy 4 is composed of 4 hydrologic and salinity control features, 9 marsh restoration features, 2 bank and shoreline protection/stabilization

features, all Chenier reforestation features, and protection and preservation of the Sabine Lake Oyster Reef.

Strategy 5: **Interior Perimeter Salinity Control.** The focus of Strategy 5 is the control of salinity levels within the interior areas of the Calcasieu-Sabine basin and the Cameron-Creole Watershed. There are no hydrologic and salinity control structures at the main passes, with the expectation that salinity control around the perimeter of Calcasieu Lake and the GIWW could result in lower salinities in the interior marshes at a lower cost than entry salinity control. Strategy 5 includes those marsh restoration and bank and shoreline protection/stabilization features that could reinforce perimeters. Strategy 5 is composed of 6 hydrologic and salinity control features, 9 marsh restoration features, 2 bank and shoreline protection/stabilization features, all Chenier reforestation features, and preservation of the Sabine Lake Oyster Reef.

Strategy 6: **Marsh and Shoreline (Minimal Hydrologic & Salinity Control).** Strategy 6 includes minimal hydrologic and salinity control features and focuses on restoring marsh and protecting/stabilizing shorelines. Strategy 6 was formulated to evaluate the effectiveness of ecosystem restoration with the existing salinity regime and is composed of 5 hydrologic and salinity control features, 18 marsh restoration features, 5 bank and shoreline protection/stabilization features, all Chenier reforestation features, and preservation of the Sabine Lake Oyster Reef.

Strategy 7: **Entry Salinity Control (Stand-alone measure).** Strategy 7 would manage salinity being introduced through the Calcasieu Ship Channel into Calcasieu Lake and surrounding wetlands through a Calcasieu Ship Channel Salinity Control Structure (Plan "A"). It is combinable with Calcasieu alternatives and is also evaluated as a stand-alone plan.

Table 2-12: Focused Array of NER Alternative Plans

PLAN #	IWR label	ALTERNATIVE PLAN NAME
CMA-1	C1A+M1	Comprehensive Large Integrated Restoration w/ Entry Salinity Control
CM-1	C1+M1	Comprehensive Large Integrated Restoration
CA-1	C1A	Calcasieu Large Integrated Restoration w/ Entry Salinity Control
C-1	C1	Calcasieu Large Integrated Restoration
M-1	M1	Mermentau Large Integrated Restoration
CMA-2	C2A+M2	Comprehensive Moderate Integrated Restoration w/ Entry Salinity Control
CM-2	C2+M2	Comprehensive Moderate Integrated Restoration
CA-2	C2A	Calcasieu Moderate Integrated Restoration w/ Entry Salinity Control
C-2	C2	Calcasieu Moderate Integrated Restoration
M-2	M2	Mermentau Moderate Integrated Restoration
CMA-3	C3A+M3	Comprehensive Moderate Integrated Restoration w/ Gum Cove & Entry Salinity Control
CM-3	C3+M3	Comprehensive Moderate Integrated Restoration
CA-3	C3A	Calcasieu Moderate Integrated Restoration w/ Gum Cove & Entry Salinity Control
C-3	C3	Calcasieu Moderate Integrated Restoration
M-3	M3	Mermentau Moderate Integrated Restoration
CMA-4	C4A+M4	Comprehensive Small Integrated Restoration w/ Entry Salinity Control
CM-4	C4+M4	Comprehensive Small Integrated Restoration
CA-4	C4A	Calcasieu Small Integrated Restoration w/ Entry Salinity Control
C-4	C4	Calcasieu Small Integrated Restoration

M-4	M4	Mermentau Small Integrated Restoration
CM-5	C5+M5	Comprehensive Interior Perimeter Salinity Control
C-5	C5	Calcasieu Interior Perimeter Salinity Control
M-5	M5	Mermentau Interior Perimeter Salinity Control
CM-6	C6+M6	Comprehensive Marsh & Shoreline
C-6	C6	Calcasieu Marsh & Shoreline
M-6	M6	Mermentau Marsh & Shoreline
A	A	Entry Salinity Control

2.4.4 Comparison of the Focused Array of NER Alternative Plans

The calculated WVA benefits are measured in average annual habitat units (net AAHUs) and cost estimates were examined using the Institute for Water Resources Planning Suite (IWR Plan), the results of which helped guide the identification of a TSP. The State Master Plan Models were used to compare benefits among alternatives in acres and AAHUs, and compared them to the Future Without Project (FWOP) Alternative. The WVA analysis used to generate the benefits in AAHUs has six variables that must be projected into the future for the FWOP and Future With Project (FWP) alternatives.

For the focused array of alternatives, the State Master Plan modeling effort was used with input from the hydrodynamic model (MIKE-FLOOD) to estimate land and water changes. The alternatives were run in the MIKE-FLOOD model under the Intermediate RSLR scenario to predict salinity, water levels, and flows. The results of the MIKE-FLOOD modeling effort were input into the various modules of the State Master Plan model to predict wetland loss and other trends over time. The State Master Plan model included accretion and subsidence projections. For marsh restoration and shoreline protection/stabilization projects, the WVA analysis process was performed using basic assumptions from the CWPPRA program.

Table 2-13: Alternative Plan Components

Mermentau Basin Calcasieu Basin			**Strategy 1/1A**	**Strategy 2/2A**	**Strategy 3/3A**	**Strategy 4/4A**	**Strategy 5**	**Strategy 6**	**Strategy 7 (or A)**
Measure	Feature	No Action	Large Integrated Restoration across Basins	Moderate Integrated Restoration across Basins	Moderate Integrated Restoration + Gum Cove	Small Integrated Restoration	Interior Perimeter Salinity Control	Marsh & Shoreline Focus	Entry Salinity Control
Hydrologic & Salinity Control									
	7	0	0/X	0/X	0/X	0/X	0/X	0/X	X
	13	0	X	X	X	X	X	X	0
	17a-c	0	X	X	X	0	X	X	0
	48	0	0	0	0	0	0	0	0
	74a	0	X	X	X	X	X	X	0
	407	0	0	0	X	0	X	0	0
Marsh Restoration									
	3a1	0	0	0	0	X	X	0	0
	3c1	0	X	X	X	X	X	X	0
	3c2	0	X	X	X	0	0	X	0
	3c3	0	X	X	X	0	0	X	0
	3c4	0	X	X	X	0	0	X	0

	3c5	0	X	X	X	0	0	X	0
	47a1	0	X	X	X	X	X	X	0
	47a2	0	X	X	X	X	X	X	0
	47c1	0	X	X	X	X	X	X	0
	47c2	0	X	0	0	0	0	X	0
	124a	0	X	0	0	0	0	X	0
	124b	0	X	0	0	0	0	X	0
	124c	0	X	X	X	X	X	X	0
	124d	0	X	X	X	X	X	X	0
	127c1	0	X	0	0	0	0	X	0
	127c2	0	X	X	X	0	0	X	0
	127c3	0	X	X	X	X	X	X	0
	306a1	0	X	X	X	X	X	X	0
	306a2	0	X	0	0	0	0	X	0
Shoreline Protection/Stabilization									
	5a	0	X	X	X	X	X	X	0
	6b1	0	X	X	X	X	X	X	0
	6b2	0	X	X	X	X	X	X	0
	6b3	0	X	X	X	X	X	X	0
	16b	0	X	0	0	X	X	0	0
	99a	0	X	0	0	0	0	X	0
	113b2	0	X	0	0	0	0	0	0
Chenier Reforestation (both basins)									
	CR	0	X	X	X	X	X	X	0

2.4.4.1 Cost Estimates

The construction cost and schedule estimates for the measures were developed from similar projects in the Southwest Coastal Louisiana study area (such as through the CWPPRA program), with input as needed from other recent projects coast-wide. This would include mobilization and demobilization costs, price per cubic yard of dredged material or per ton of rock, depending on the measure type, and other line items as appropriate. The maintenance schedule for shoreline protection/stabilization was based on anticipated settlement rates calculated from the existing nearby geotechnical data, as available, and similar projects in the vicinity. The renourishment schedule for the marsh restoration features was developed through an optimization process by which the total costs and benefits for different maintenance schedules were considered at five-year intervals. This process determined that a 30-year renourishment cycle optimized costs per unit benefit (in AAHU). Costs for hydrologic and salinity control features were calculated, along with the features from the State Master Plan. The costs of alternative plans are the sums of the costs of the individual features (see Table 2-14). While some cost-savings may be realized through synergistic execution of adjacent or nearby project features, for a conservative cost estimate this synergy was not assumed. Since the NER plan is intended to reasonably maximize environmental benefits and since NER planning promotes the avoidance of environmental features that require mitigation, no costs for unavoidable wetland impacts have been factored into the preliminary cost estimates. All restoration features in the various alternatives have been designed to not require mitigation. Preliminary high and low cost estimates for plans that contain Plan “A” (Calcasieu Ship Channel Salinity Control Structure) were developed as starting points to account for potential navigation impacts.

Table 2-14: NER Cost Estimates and Benefits

Plan #	Cost $ Low Nav	Cost $ High Nav	AAHU's
CMA-1	3,049,836,909	3,104,429,860	29,070
CM-1	2,465,675,681	2,465,675,681	23,101
CA-1	1,591,668,028	1,646,260,979	12,844
C-1	1,007,506,800	1,007,506,800	6,875
M-1	1,458,168,881	1,458,168,881	16,226
CMA-2	2,390,030,484	2,444,623,435	25,187
CM-2	1,901,658,190	1,901,658,190	19,218
CA-2	1,495,879,094	1,550,472,045	13,898
C-2	1,007,506,800	1,007,506,800	7,929
M-2	894,151,390	894,151,390	11,289
CMA-3	2,697,850,484	2,752,443,435	18,959
CM-3	2,113,689,256	2,113,689,256	12,990
CA-3	1,803,699,094	1,858,292,045	7,982
C-3	1,219,537,866	1,219,537,866	2,013
M-3	894,151,390	894,151,390	10,977
CMA-4	1,903,984,167	1,958,577,118	22,508
CM-4	1,319,822,939	1,319,822,939	16,539
CA-4	1,041,573,707	1,096,166,658	11,005
C-4	457,412,479	457,412,479	5,036
M-4	862,410,460	862,410,460	11,503
CM-5	1,664,058,939	1,664,058,939	15,537
C-5	801,648,479	801,648,479	4,457
M-5	862,410,460	862,410,460	11,080
CM-6	2,321,547,245	2,321,547,245	23,026
C-6	1,005,766,800	1,005,766,800	9,240
M-6	1,315,780,445	1,315,780,445	13,786
A	584,161,228	638,754,179	5,969

2.4.4.2 CE/ICA Results

The focused array of alternative NER plans were compared considering cost effectiveness and incremental cost analysis (CE/ICA) to inform environmental investment decision making. Cost effectiveness is determined based upon a finding that no other plan provides a higher output level of acres restored for the same or less cost. Incremental cost analysis is the determination of the greatest increase in output (acres restored) for the least increase in cost. Use of these tools helps decision makers determine the most desirable level of outputs (restored acres) compared to costs.

In the CE/ICA analysis shown in Figure 2-8, a Rough Order of Magnitude (ROM) average annual cost of $10,000,000 was added to plans that include Plan “A” to represent the potentially high navigation impact cost resulting from the operable closure structure. The cost in this

analysis represents traffic delays to all 2011 deep draft traffic in the Calcasieu Ship Channel. All alternatives with Plan "A" were run through CE/ICA both with and without the structure in place in order to isolate the relative performance of the structure. Plans in red are best-buys and those in blue are cost-effective.

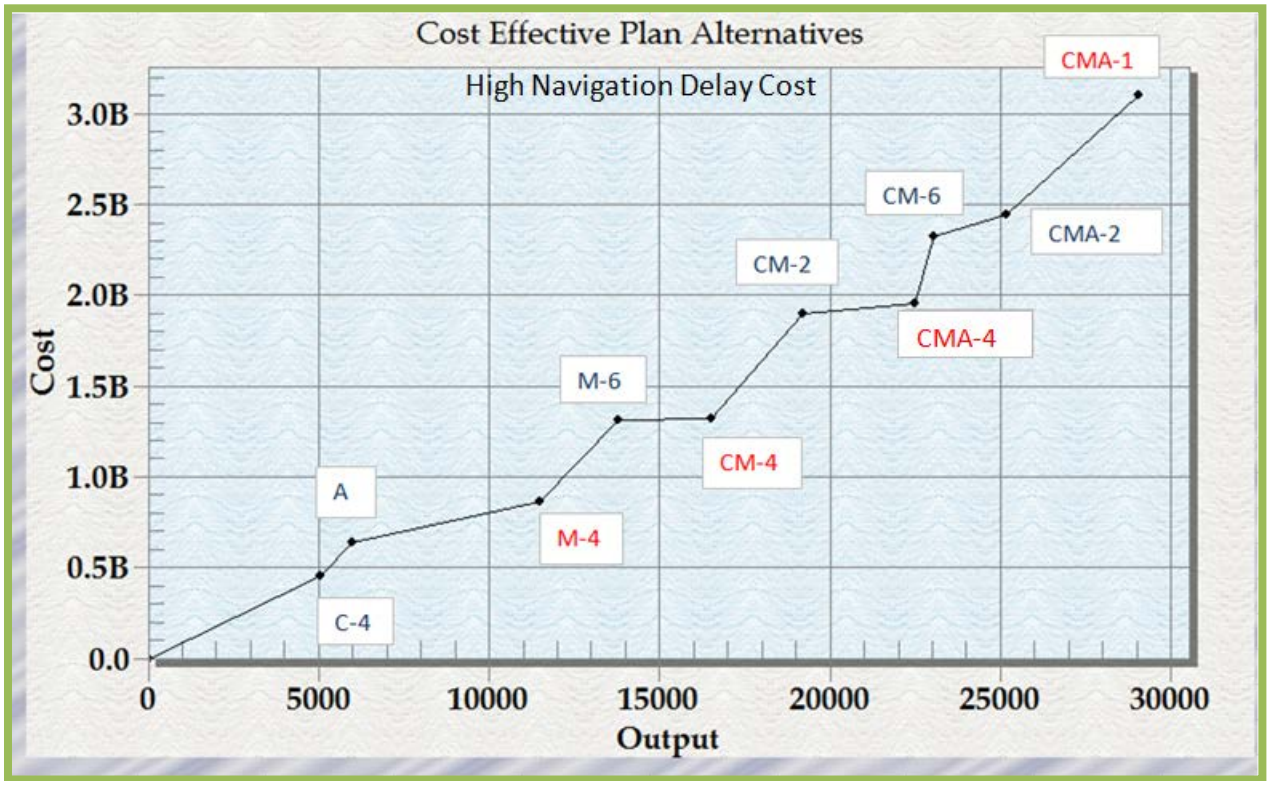


Figure 2-8: CE/ICA analysis using high navigation cost.

The second CE/ICA analysis is shown in Figure 2-9; ran identical sets of plans, but used a lower ROM average annual cost of $7,672,500 to represent navigation delay costs caused by the Calcasieu Ship Channel Salinity Control Structure. The lower cost accounts for delays to vessels that transited on the Calcasieu Ship Channel in 2011 with drafts between 15 and 35 feet. The purpose of using this lower cost estimate is to represent an operating scheme that would allow the Calcasieu Ship Channel Salinity Control Structure to remain open during high tide, which is when the deepest draft vessels transit. Thus, a minimum representation of the impact of the structure closure is to add traffic delays for only non deep-draft vessels. The cost does not include tug assistance costs or any other ancillary impacts of a closure of the Calcasieu Ship Channel Salinity Control Structure.

In both analyses, in order to be consistent with the cost provided for the measures, the average annual cost was converted to a present value of $179,963,228. This present value cost was added to the cost of the plans that contain the Calcasieu Ship Channel Salinity Control Structure, which includes any Plan with an "A" designation.

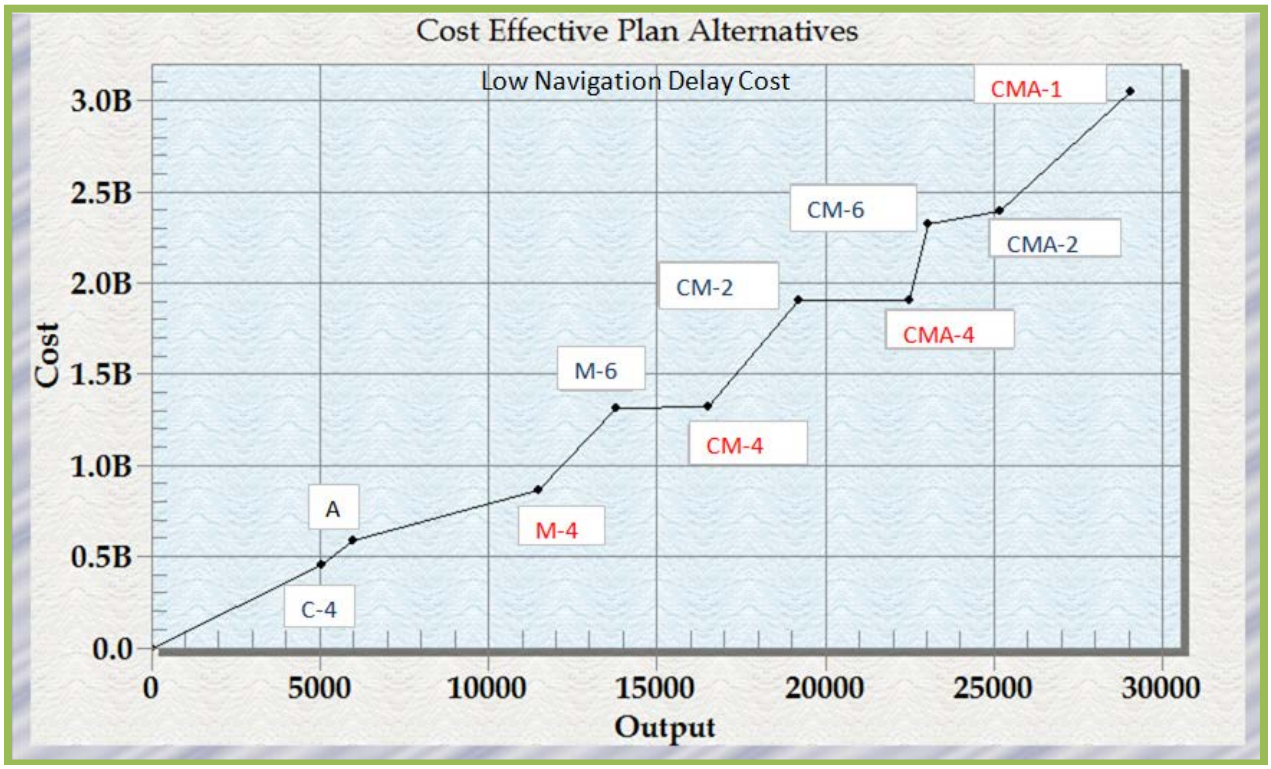


Figure 2-9: CE/ICA analysis using low navigation cost.

For all alternatives, the number of hydrologic and salinity control structures, marsh restoration features, and bank and shoreline protection/stabilization features varied depending on the plan scale and emphasis. The plans were estimated to produce between 5,000 and 29,000 acres, and their costs range from $500,000,000 to over $3,000,000,000.

Plan "A" Considerations

As part of the evaluation, plans with and without the Calcasieu Ship Channel Salinity Control Structure (Plan "A") were compared. Plan "A" could potentially provide significant environmental benefits (5,700 acres, or approximately 2,400 AAHUs) even as a stand-alone plan. Applying both low and high preliminary rough order of magnitude estimates of navigation impacts proved Plan "A" to be potentially cost-effective. Cost-effective and Best-Buy comprehensive plans containing Plan "A" exist only on the upper most portion of the cost efficient frontier. In fact, the only Best Buy plans that produce greater benefits than the TSP, Plan CM-4, are those which include Plan "A" as a component. Best-buy plans that contain the salinity control structure are significantly more expensive than plans without the structure. If the extra benefits are desired, Plan "A" alternatives are worth considering.

However, based on the evaluation of Plan "A" as a stand-alone plan, it does not demonstrate the potential to rise to a Best-Buy plan or be selected as the TSP and may fall completely out of consideration should costs be found to be higher. However, if additional benefits beyond the current TSP are desired, or necessary, there is an extremely good chance that Plan "A" would be the next best increment even if costs are found to be higher.

2.4.5 Final Array of NER Alternative Plans (*NEPA Required)

The final array is comprised of the No Action Plan, Plan M-4, and Plan CM-4. The IWR analysis indicates that the only Best Buy plans that do not contain Plan "A" are plans M-4 and CM-4. Since the negative effects to navigation are a study constraint and due to the significant cost of

the Calcasieu Ship Channel Salinity Control Structure, those Best Buy plans on the upper portion of the cost-efficient frontier were dropped from the final array. The components of the final array plans are presented in the table below. Plan M-4 features are those that are located in the Mermentau/Teche-Vermilion basin. Plan CM-4 consists of all the features listed in Table 2-15.

Table 2-15: NER Alternative Plan Features

Basin	Category	Feature	Description
Mermentau/Teche-Vermilion (M-4)	Hydrologic/ Salinity Control	13	Little Pecan Bayou Saltwater Sill. Construction of a rock weir with a crest (top) elevation of -3.1 ft and an opening of 60 ft at a bottom invert of -11.1 ft.
	Marsh Restoration	47a1	Marsh restoration using dredged material south of Hwy 82. Located adjacent to the south side of Hwy 82 approximately 4.5 miles west of Grand Chenier. 88 marsh acres would be restored and 933 acres would be nourished from 3M cubic yards of dredged material with one future renourishment cycle.
		47a2	Marsh restoration using dredged material south of Hwy 82. Located on the south side of Hwy 82 approximately 4.5 miles west of Grand Chenier. 1,297 marsh acres would be restored and 126 acres would be nourished from 8.8M cubic yards of dredged material with one future renourishment cycle.
		47c1	Marsh restoration using dredged material south of Hwy 82. Located on the south side of Highway 82 approximately 4.5 miles west of Grand Chenier. 1,304 marsh acres would be restored and 4 acres would be nourished from 8.6M cubic yards of dredged material with one future renourishment cycle.
		127c3	Marsh restoration at Pecan Island. Located west of the Freshwater Bayou Canal and approximately 5 miles north of the Freshwater Bayou locks. 832 marsh acres would be restored and 62 acres would be nourished from 7.3M cubic yards of dredged material with one future renourishment cycle.
		306a1	Rainey marsh restoration at Christian Marsh. Located east of the Freshwater Bayou Canal and approximately 5 miles north of the Freshwater Bayou locks. 627 marsh acres would be restored and 1,269 acres would be nourished from 8.1M cubic yards of dredged material with one future renourishment cycle.
	Shoreline Protection/ Stabilization	6b1	Gulf shoreline protection/stabilization from Calcasieu River to Freshwater Bayou. 11.1 miles of Gulf shoreline protection consisting of a reef breakwater with a lightweight aggregate core. Located ~150 ft offshore consisting of geotextile fabric and stone built to an 18 ft crest width.
		6b2	Gulf shoreline protection/stabilization from Calcasieu River to Freshwater Bayou. 8.1 miles of Gulf shoreline protection consisting of a reef breakwater with a lightweight aggregate core. Located ~150 ft offshore consisting of geotextile fabric and stone built to an 18 ft crest width.
		6b3	Gulf shoreline protection/stabilization from Calcasieu River to Freshwater Bayou. 7.2 miles of Gulf shoreline protection consisting of a reef breakwater with a lightweight aggregate core. Located ~150 ft offshore consisting of geotextile fabric and stone built to an 18 ft crest width.
		16b	Fortify spoil banks of the GIWW and Freshwater Bayou. Approximately 15.4 miles of rock revetment at three critical locations to prevent shoreline breaching. Rock revetment would be built to +4 ft with a 4 ft crown. Two maintenance lifts will be

			required.
	Chenier Reforestation	CR	13 separate Chenier locations would be replanted. Approximately 435 seedlings per acre, at 10 ft x 10 ft spacing, with invasive species control incorporated.
Calcasieu/ Sabine (CM-4) (Includes all features in this table)	Hydrologic/ Salinity Control	74a	Cameron-Creole Spillway. Located at the breach in the levee south of Lambert Bayou this canal would act as a drainage manifold. The outfall channel into Calcasieu Lake would rock-lined for scour protection and built to +4 ft.
	Marsh Restoration	3a1	Beneficial use of dredged material from the Calcasieu Ship Channel. Located adjacent to the southern shoreline of the GIWW west of the Calcasieu Ship Channel near Black Lake. 599 marsh acres would be restored from 5.3M cubic yards of dredged material with one future renourishment cycle.
		3c1	Beneficial use of dredged material from the Calcasieu Ship Channel. Located adjacent to the eastern rim of Calcasieu Lake and situated within the Cameron-Creole Watershed area. 1,765 marsh acres would be restored and 450 acres would be nourished from 10.2M cubic yards of dredged material with one future renourishment cycle.
		124c	Marsh restoraton at Mud Lake. Located adjacent and north of Highway 82 and east of Mud Lake. 1,908 marsh acres would be restored and 734 acres would be nourished from 11.1M cubic yards of dredged material with one future renourishment cycle.
		124d	Marsh restoration at Mud Lake. Located west of the Calcasieu Ship Channel and adjacent to the southern rim of West Cove. 159 marsh acres would be restored and 448 acres would be nourished from 1.4M cubic yards of dredged material with one future renourishment cycle.
	Shoreline Protection/ Stabilization	5a	Holly Beach Shoreline Stabilization Breakwaters. Consists of construction of approximately 8.7 miles of rock and low action breakwaters and is a continuation of existing breakwaters. Crown elevation of +1.5 ft with a crown width of 30 ft. Two maintenance lifts will be required.
	Chenier Reforestation	CR	22 separate Chenier locations would be replanted. Approximately 435 seedlings per acre, at 10 ft x 10 ft spacing, with invasive species control incorporated.
	Oyster Reef Preservation	ORP	Preservation of a large oyster reef in Sabine Lake through the enforcement of oyster dredging restrictions.

2.5 Identification of the NER TSP

Plan CM-4 is not only the first comprehensive Best Buy plan but also the only Best Buy plan which does not include Plan A. For these reasons, and since evaluation of the Calcasieu Ship Channel Salinity Control Structure will require a significantly larger financial investment, Plan CM-4 is recommended as the NER TSP.

<u>Description of the NER TSP:</u>

- **Marsh Restoration.** Nine marsh restoration and nourishment features consist of delivering sediments to former marsh areas and eroding marsh areas (minimum of 100 acres) that have water levels of less than two feet and that have been optimized to preserve or restore critical geomorphologic features to restore vegetated wetlands. This involves excavation of significant quantities and delivery of borrow material to restoration sites through designated corridors. Some restoration sites may require containment to hold sediments in place. Details for each of the restoration sites and their borrow source can be found in Appendix A.

The marsh restoration locations include: (a) three areas on the south side of Highway 82 approximately 4.5 miles west of Grand Chenier; (b) Pecan Island west of the Freshwater Bayou Canal approximately 5 miles north of the Freshwater Bayou locks; (c) Christian Marsh located east of Freshwater Bayou Canal and approximately 5 miles north of Freshwater Bayou locks; (d) southern shoreline of GIWW west of Calcasieu Ship Channel near Black Lake; (e) eastern rim of Calcasieu Lake within the Cameron-Creole Watershed; (f) east of Mud Lake and north of Highway 82; (g) Mud Lake west of Calcasieu Ship Channel adjacent to southern rim of West Cove. These marsh features will restore approximately 8,600 acres and nourish 4,000 acres, resulting in net 8,700 acres. Dredged material sources will be the Calcasieu Ship Channel and other nearby sites. All marsh restoration locations will have one future re-nourishment cycle.

- **Hydrologic and Salinity Control.** The two hydrologic and salinity control features consist of: (a) the existing Cameron-Creole Spillway south of Lambert Bayou will serve as a drainage manifold and the outfall channel into Calcasieu Lake will be rock-lined for scour protection and built to +4 feet; and (b) the Little Pecan Bayou Stillwater Sill will include construction of a rock weir. These features will regulate the flow of water in certain areas, inhibit salinity intrusion above a certain threshold, and increase wetland productivity to restore 6,100 net acres.
- **Shoreline Protection/Stabilization.** The five Gulf shoreline protection/stabilization features span approximately 267,000 linear feet resulting in 5,500 net acres will be used to reduce erosion of canal banks and shorelines in critical areas in order to protect adjacent wetlands and critical geomorphic features. Only wetland areas in excess of 100 net acres are included. Multiple locations of approximately 26.4 miles from Calcasieu River to Freshwater Bayou consisting of reef breakwaters with lightweight aggregate core located approximately 150’ offshore- geotextile and stone built to an 18 foot crest width. In addition, approximately 15.4 miles of rock revetment built to +4 feet with a 4 foot crown will be placed at three locations to fortify spoil banks of the GIWW and Freshwater Bayou. Two future maintenance lifts will be required. Rock and breakwaters will also be placed at Holly Beach as a continuation of existing breakwaters; two future maintenance lifts will be required.
- **Oyster Reef Preservation.** The existing oyster reef in the Sabine Lake near the Sabine Pass will be preserved through the enforcement of perpetual oyster harvesting restrictions.
- **Chenier Reforestation.** Chenier restoration consists of replanting of 435 seedlings per acre at 10’ x 10’ spacing, in 22 Chenier locations on 1,400 acres in Cameron and Vermilion parishes. Invasive species control and eradication is also included.

The preliminary first cost of the NER TSP is estimated at $992,000,000

2.6 Summary of Accounts and Comparison of Alternatives

To facilitate evaluation and comparison of the alternatives, the 1983 Principles and Guidelines lay out four Federal Accounts that are used to assess the effects of alternatives. The accounts are National Economic Development (NED), Environmental Quality (EQ), Other Social Effects (OSE), and Regional Economic Development (RED).

- The NED account displays changes in the economic value of the national output of goods and services. The 1983 Principles and Guidelines require the identification of an NED plan from among the alternatives.
- The EQ account displays non monetary effects on significant natural and cultural resources.
- The RED account registers changes in the distribution of economic activity that result from each alternative plan. Evaluations of regional effects are to be carried out using nationally consistent projections of income, employment, output, and population.
- The OSE account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts.

NED TSP

Plan 0: **No Action.** No NED benefits would be associated with the No Action alternative. There would continue to be adverse impacts to the EQ account as salinity levels increase in the area and existing wetlands continue to degrade and disappear. These impacts will continue to affect residents and infrastructure through the encroachment of open water (OSE). Reducing the protective wetlands in the area could have negative effects to RED by impacting major oil refineries, shipping channels, and industrial uses in the study area.

Plan 7: **Nonstructural Justified Reaches Plan (TSP).** This plan provides positive net NED benefits and has a positive benefit-cost ratio. Impacts to EQ would be minimal as no significant features would be constructed and structures to be elevated, acquired, or floodproofed already exist. Effects to RED would be beneficial due to the implementation of risk reduction features and the prevention of damages. Effects to OSE would be minimal for justified reaches where nonstructural measures are implemented though the potential for inundation and other storm-related damages will continue unabated for structures that are not addressed under this alternative. Implementing this alternative would not address the most populated communities.

Plan 8: **Nonstructural 100-Year Floodplain Plan.** This plan provides positive net NED benefits but has a negative benefit-cost ratio. Impacts to EQ would be minimal as no significant features would be constructed and structures to be elevated, acquired, or floodproofed already exist. Effects to RED would be beneficial due to the implementation of risk reduction features and the prevention of damages. Effects to OSE would be minimal for those reaches where nonstructural measures are implemented though the potential for inundation and other storm-related damages will continue unabated for structures that are not addressed under this alternative. Implementing this alternative would address the most populated communities.

NER TSP

Plan 0: **No Action.** Under this alternative, no ecosystem restoration would take place. Coastal wetlands would continue to degrade and disappear, further weakening the coastal landscape and resulting in significant impacts to important habitats. Infrastructure would continue to become vulnerable to the increased effects of storm surge and relative sea-level rise through the loss of a protective wetland buffer.

Plan M4: **Mermentau Small Integrated Restoration.** This alternative was formulated for NER so it does not have specific NED or RED benefits calculated. Effects to EQ would increase for this alternative but only for the Mermentau Basin. Positive effects to OSE are expected through the restoration of wetland habitat and its associated benefits to plant and wildlife species, salinity reduction, and improvement to the coastal landscape.

Plan CM-4: **Comprehensive Small Integrated Restoration (TSP).** This alternative was formulated for NER so it does not have specific NED or RED benefits calculated. Effects to EQ would increase for this alternative across the

Calcasieu and Mermentau Basins. Positive effects to OSE are expected through the restoration of wetland habitat and its associated benefits to plant and wildlife species, salinity reduction, and improvement to the coastal landscape. This alternative offers the most cost-effective and comprehensive benefit.

2.7 Views of the Non-Federal Sponsor

CPRAB recognizes the importance of hurricane and storm surge risk reduction and ecosystem restoration in Cameron, Calcasieu, and Vermilion parishes. This study is included in the State Master Plan and is supported by the Louisiana Congressional delegation. Construction of the NED TSP would provide improved hurricane and storm surge risk reduction, reduce life, health, and safety risks, as well as interruptions to hurricane evacuation and emergency response routes. The NER component will rebuild, restore and protect the critical Chenier Plain providing a multitude of environmental benefits to southwest coastal Louisiana. CPRAB and numerous local stakeholders have participated with CEMVN in the PDT process and have provided input in the development of the various measures and alternatives to formulate the plans. CPRAB currently has expressed no objection to the features of the NER and NED TSPs, and both TSPs are consistent with the State Master Plan.

3.0 ENVIRONMENTAL CONSEQUENCES (*NEPA REQUIRED)

This chapter describes the environmental consequences associated with the alternatives for the non structural Hurricane and Storm Damage Risk Reduction (HSDRR**)** NED plans and the ecosystem restoration NER plans. The impacts described here are programmatic in nature. Subsequent NEPA documents will analyze in detail site specific project(s) impacts prior to implementation.

3.1 The Human Environment

3.1.1.1 Population and Housing

HSDRR (NED) Plan

Alternative - Nonstructural Justified Reaches (TSP)

Direct impacts include the inconvenience of residents having to move their personal possessions and relocate to a temporary residence while their residences are being raised or new residence in the case of buy outs.

Indirect Impacts of the TSP NED plan include reduced flood risk from the surges associated with tropical events for population and housing deemed eligible. This reduction in flood risk would lead to greater stability and sustainability of population and housing resources. Furthermore, if a residence is elevated, then access to the elevated residences could be more difficult, especially for the elderly and physically handicapped, even if retrofitted. For population and housing not included in the nonstructural plan either due to ineligibility or location outside of the justified reaches, indirect impacts include increased risk for flood damage and corresponding increased insurance costs and decreased property values as discussed in more detail in Sections 1.8.1.1 and 1.8.1.6, the No Action Alternative.

Alternative – Nonstructural 100-year Floodplain

The impacts from this alternative are similar but for the most part greater than the impacts from the Nonstructural Justified Reaches (TSP) alternative because of the larger numbers of structures that would be included in the program. This is true for all resources hence a discussion of impacts will not be added to each of the following resource unless there is a significant reason for it to be addressed separately in that resource. The scale of the differences would vary by resource.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Restoration features of this alternative would have no direct impacts on population and housing. Indirect impacts would include decreasing the rate of shoreline erosion, thereby, preserving the temporary population of the Holly Beach camp community located along the shoreline of the Gulf of Mexico.

Alternative – Mermentau Small Integrated Restoration Plan

Impacts are the same as the Mermentau Basin (MB) component of the TSP.

3.1.1.2 Employment, Business, and

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

Direct impacts associated with the flood proofing of businesses include business disruption, shutdown and temporary relocation while the measure is being applied.

Indirect Impacts would include reduced flood risk from the surges associated with tropical events which could promote increased stability for employment and business, and industrial activity in the study area. Indirect impacts to industrial and agricultural structures, which are not

included in the nonstructural plan, include a risk of flood damage which is discussed in Section 1.8.1.2, the No Action Alternative. No loss of employment is expected.

Ecosystem Restoration (NER) Plans
Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
No direct or indirect impacts

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP.

3.1.1.3 Public Facilities and Services

HSDRR (NED) Plans
Alternative - Nonstructural Justified Reaches (TSP)
Direct impacts associated with the TSP include interruption or unavailability of public facilities and services during temporary closure or relocation during flood proofing.

Indirect impacts include reduced flood risk from the surges associated with tropical events for public facilities and services in the area thereby reducing the number of days a structure is unavailable for use and minimizing the inconvenience to the general public. Indirect impacts to public facilities and services not included in the plan would be the same as the no-action alternative.

Ecosystem Restoration (NER) Plans
Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
Restoration features would have no direct, indirect or cumulative impacts on public facilities or services.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts same as MB component of the TSP.

3.1.1.4 Transportation

HSDRR (NED) Plans
Alternative - Nonstructural Justified Reaches (TSP)
There could be minor indirect short term impact to transportation due to construction related activities from both elevations and buyouts. These impacts will vary depending on the number of structures in each category and the timing of the activities. There would be no long term impact.

Ecosystem Restoration (NER) Plans
Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
No direct impacts on transportation. Indirect impacts would include mitigating the wave action that Highway 27 is routinely subject to, thereby reducing the frequency and intensity of the damages it sustains.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP

3.1.1.5 Community and Regional Growth

HSDRR (NED) Plan
Alternative - Nonstructural Justified Reaches (TSP)

No direct impacts. Indirect impacts would include reduced risk of damage for communities from the storm surges associated with tropical events, thus preserving growth opportunities for communities in the region.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct or indirect impacts.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as MB component of the TSP

3.1.1.6 Tax Revenues and Property Values

HSDRR (NED) Plan

Alternative - Nonstructural Justified Reaches (TSP)

Parish sales tax revenue would likely increase during implementation of nonstructural measures as a result of an expected influx of workers and construction expenditures from outside of the area. Construction activities associated would provide jobs and could increase the level of spending, labor, and capital expenditures in the area. Indirect impacts may include an increase in tax revenue and property values due to the increased risk reduction from flooding for residential properties and businesses. The tax revenues and property values for properties no included in the program would be the same as the without project values.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct effects to tax revenues and property values. Indirect effects would include the prevention of land loss, which could result in localized positive effects of maintaining tax revenues and property values.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

3.1.1.7 Other Social Effects (OSE)

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

A summary of OSE's is presented in the table 3-1. These include reduction in risks associated with damages from tropical/hurricane storm surge events to housing units, public facilities, and commercial structures located within reaches where the TSP is implemented, as well as improvement in the health and safety of those residents living within these and surrounding areas. The social vulnerability of all three parishes would be reduced, and thus, the potential for long-term growth and sustainability would be enhanced. These areas would be at a reduced risk of incurring costs associated with clean-up, debris removal, and building and infrastructure repair as a result of flood events.

Table 3-1: Summary of Other Social Effects.

OSE Alternative Evaluation				
Social Factors and Metrics	*Nonstructural Measures*	*CB and MB Salinity Control*	*MB*	*No Action*
	DL / FE	DL / FE	DL / FE	DL / FE
Physical Health/Safety	1/2	1/1	0/0	-1/-2
Regional Healthcare	1/2	1/1	0/0	0/-2

Employment Opportunities	1/3	0/0	0/0	-1/-3
Community Cohesion	1/2	0/0	0/0	-1/-1
Vulnerable Groups	1/1	1/1	0/0	-1/-2
Residents of Study Area	1/1	1/1	0/0	-1/-2
Recreational Activities	1/2	1/2	0/1	-1/-2
Impacts are in comparison to the Without Project Condition DL = impacts to daily life when there is no storm/flooding FE = impacts during a storm/flood event Scores can range from -3 (significant negative impact) to +3 (significant positive impact)				

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

This alternative would reduce the risks associated with habitat damage via saltwater intrusion, shoreline retreat, and loss of geomorphologic infrastructure. The area's social vulnerability would be reduced under this alternative via improved leisure and recreation opportunities, access to health and safety facilities, economic vitality, and reduced stress. Thus, the potential for long-term growth and sustainability would be enhanced.

Alternative - Mermentau Small Integrated Restoration Plans

Impact are the same as the MB component of the TSP.

3.1.1.8 Community Cohesion

HSDRR (NED) Plan

Alternative - Nonstructural Justified Reaches (TSP)

Direct Impacts would include the temporary displacement of residents residing in those reaches benefiting by non-structural measures. If residential structures were elevated then the residents would be temporarily relocated, disrupting community cohesion during the elevation process. Furthermore, non-residential structures that serve as meeting places for the community could become temporarily unavailable during the flood proofing process.

Indirect impacts for the nonstructural plan would include reduced risk for select communities from the damages associated with tropical/hurricane storm surge events, thus preserving the cohesion of these communities in the region. Depending on the method used on any individual property there may be a cumulative change in the communities.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

No direct or indirect.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

3.1.1.9 Environmental Justice

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

Population groups residing or working near the construction site itself may experience direct impacts due to the construction traffic, noise, and dust. Indirect impacts include a decrease in risk of damage from 1 percent (and more frequent) exceedance storm events for minority and/or low-income populations residing in those reaches where the nonstructural plan is implemented.

It is assumed that all structures within the 100-year flood zone in the economically justified 11 reaches are flood-proofed, elevated, or acquired; therefore all residents within the 11 reaches, irrespective of race, ethnicity, or income, would be expected to be similarly impacted. Further evaluation will determine if the federal action causes a disproportionate impact to low-income or minority communities.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Many of the areas are sparsely populated or devoid of permanent structures and/or population. Construction of control structures to reduce saltwater intrusion and tidal influx would temporarily impact leisure and recreation at any nearby camps or designated fishing and hunting spots. Access to some areas due to marsh restoration and nourishment activities may be temporarily interrupted. Impacts due to shoreline protection construction would also be temporary. The long-term benefits of salinity control, marsh restoration, shoreline protection, bank stabilization, chenier reforestation, and oyster reef restoration would improve wetland habitat which would subsequently improve leisure and recreation opportunities. If this alternative encourages regional economic growth, any additional jobs created may benefit minority and/or low-income groups living within the project area. Temporary impacts from construction activities due to increased turbidity, noise, and access interruption are compensated for by the opportunity for long-term positive cumulative impacts as other restoration programs improve the habitat and sustainability of coastal Louisiana.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP.

3.2 Water Environment (Hydrology and Hydraulics)

3.2.1.1 Flow and Water Levels

HSDRR (NED) Plan

Alternative - Nonstructural Justified Reaches (TSP)

Potential direct and indirect impacts to flow and water depending on the method used.

1. Raising of structures with the use of pilings or buyout could increase storage capacity and lower the surge elevations for those structures not elevated.
2. Raising of structures with the use of earthen mounds, flood proofing or individual ring levees could decrease storage capacity and raise the surge elevations for those structures that not elevated.
3. Raising of structures with the use of cinderblock chain wall would have similar impacts as existing conditions on storage capacity and surge elevations since it would mimic existing conditions of the home.

The total level of impact would be dependent on the combination of methods and number of structures in each of those methods but at the same time would be minor.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Hydro/Salinity: General flow patterns would not change.

- *Marsh Restoration*: Existing water levels in fragmented marsh and shallow open water areas would be converted to marsh habitat. Water levels in adjacent lakes would not change. Flows would generally overflow restored and nourished marsh areas.
- *Shoreline Protection*: Segmented breakwaters along the Gulf would dissipate the high energy Gulf waves without changing water levels or flows. Rather, these structures would provide conditions conducive to land building behind them. Interior shoreline protection

measures will not alter flows or water levels. Rather, these structures will reduce erosion caused by waves.

- *Cheniers and Oyster Reef*: No direct or indirect impacts.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts same as MB component of TSP.

3.2.1.2 Water Quality and Salinity

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)
Direct impacts of nonstructural component would be associated with construction for raising of structures. Indirect impacts of raising structures would be the prevention of flooding during storm surge which would reduce water quality impacts in comparison to FWOP conditions.

Construction impacts to runoff would be minimized through implementation of a Stormwater Pollution Prevention Plan (SWPPP) (USEPA 2012). Any structure demolition and removal would be required to adhere to applicable regulations pertaining to surface water quality, such as Louisiana Permitted Discharge Elimination System (LPDES) permitting. Structures not either raised or demolished/removed face the risk of flooding and are capable of releasing constituents associated with structure and housed materials; for a local example of water quality impacts of flooded structures please see Skrobialowski et al. (2007)

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
Direct impacts of ecosystem restoration features would convert existing open water, wetland, and low-quality chenier habitat to oyster reef, marsh, and improved chenier habitat, hydrologic structure, and shoreline protection features. Because rock, fill, and construction materials for proposed hydrologic/salinity control and shoreline protection features are anticipated to be free of contaminants, discharge of these materials into existing adjacent waters is not expected to result in adverse effects to aquatic organisms. Material proposed for construction of marsh and chenier restoration features would be evaluated to determine suitability for placement in the aquatic environment in accordance with Clean Water Act Section 404(b)(1).

Indirect impacts regarding ecosystem restoration features could lead to water quality improvements through the restoration and protection of wetland and chenier habitat. Hydrologic/salinity control structures are expected to aid in reducing salinities in some regions of the study area, the benefits of which are largely unknown, as area wetlands have likely adapted to existing salinity patterns. These structures may also impede water exchange and contribute to localized hypoxia, similar to the MRGO closure (Swarzenski et al. 2013, in preparation).

Alternative - Mermentau Small Integrated Restoration Plan
Impacts are the same as the MB component of the TSP.

3.3 Natural Environment

3.3.1.1 Sedimentation and Erosion

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)
There would be no direct or indirect.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Sediment transport at salinity control structures sites would likely be altered. Sediment delivery to coast may be reduced. Water control structures may lead to minimal local increased water levels landward (drainage from rainfall) and seaward (tidal and storm surge) when closed which may increase erosion rates.
- *Marsh Restoration*: Increased marsh surface area would increase sediment entrapment when marshes are flooded (e. g. tidal and storm surge). Restored marsh would reduce fetch over open water areas thereby reducing wind generated waves and subsequent erosion.
- *Shoreline Protection*: Sedimentation patterns in the vicinity of the features would be altered. Sediment deposition and/or erosion would occur depending on the hydrodynamics at the site. For example, the location and orientation of individual features could cause erosion and/or sediment accretion. Shoreline erosion adjacent to the features would likely be reduced.
- *Cheniers*: Tree roots would likely reduce erosion of cheniers if they are overtopped due to storms or relative sea level rise by binding sediments together. Trees would likely reduce storm surge and subsequent erosion of adjacent marshes.
- *Oyster Reefs*: Reefs would likely trap sediments and reduce erosion of the water bottom and adjacent shorelines.

Alternative - Mermentau Small Integrated Restoration
Impacts are the same as the MB component of the TSP

3.3.1.2 Soils, Water Bottoms, and Prime and Unique Farmlands

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)
Nonstructural component would have no direct impacts on soils, prime and unique farmlands, or water bottoms. However, a beneficial indirect impact through the acquisition of property in the event of a buyout of the structure could result in soils being returned to “green space” and soils that are prime and unique farmlands could become available for agriculture and use as pastureland (i.e., structures, including slab foundations, would be removed from the area).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Hydro/salinity measure MB #13 would reduce saltwater intrusion and tidal flux from the lower Mermentau River into the wetlands adjacent to Little Pecan Bayou. Construction of the retention structure would directly impact less than one acre of water bottoms on Little Pecan Bayou. Soft surface water bottoms would be replaced with rock resulting in indirect impacts to aquatic habitat. Hydric soils located in the marsh areas along Little Pecan Bayou consist primarily of Aquents (AN) frequently flooded soils; Bancker muck (BA); and Clovelly muck (CO). A major cause of wetland loss can be attributed to saltwater intrusion and erosion of hydric soils from storm surges and sea level rise. The reduction of saltwater intrusion and tidal fluctuations into Little Pecan Bayou would contribute to soil stabilization in the adjacent wetlands and provide a beneficial impact to hydric soils. No prime or unique farmlands were identified along Little Pecan Bayou. Hydro/salinity measure Calcasieu/Sabine Basin (CB) #74a is currently a spillway structure located on East Calcasieu Lake. The proposed action would evacuate storm surge waters from wetlands located behind the Cameron-Creole levee. The measure would not be used to manage daily tidal exchange from Calcasieu Lake. The structure dimensions are 204 feet wide by 1509 feet in length, and would directly impact approximately 7 acres of water bottoms in Calcasieu Lake. Bancker and Clovelly muck hydric soils are most common in the wetlands located behind the Cameron-Creole levee, as well as along the East Calcasieu Lake shore. The use of the proposed spillway channel to control or remove storm surge flood waters from the wetlands could slow or prevent further erosion and provide a beneficial impact to

hydric soils and wetlands adjacent to East Calcasieu Lake. The closest identified soils to East Calcasieu Lake and the proposed H/S #74a measure that are classified as prime farmlands consist primarily of Hackberry loamy fine sand (Hb) and Judice silty clay loam (Ju) on chenier ridge tops. Prime farmlands would not be directly impacted by the construction or use of the spillway channel, but could benefit indirectly by the prevention of future soil and land losses attributed to storm surges.

- *Marsh Restoration*: These marsh restoration features would include the beneficial use of dredged material from the Calcasieu Ship Channel and the Gulf of Mexico (Gulf) for the restoration and nourishment of marsh. Hydric soils in the marsh restoration areas consist primarily of Bancker muck, Creole mucky clay, Scatlake mucky clay, Larose mucky clay; and less frequently Allemands mucky peat, Clovelly muck, and Mermentau clay (table 3-2).

Table 3-2: Hydric soils in marsh restoration areas.

Soil Association	Acres
Allemands mucky peat (AE)	40
Bancker muck (BA)	4747
Clovelly muck (CO)	142
Creole mucky clay (CR)	3481
Larose mucky clay (LR)	503
Mermentau clay (MM and ME)	24
Scatlake mucky clay (SC)	1327

Impacts to hydric soils from the restoration and nourishment of marsh would be beneficial. As marsh is restored, hydric soils would increase and become more stable.

Soils associated with prime and unique farmlands are most common on chenier ridges, and none of these soils were identified in the marsh restoration areas. There would be no direct impacts to prime and unique farmlands as a result of the restoration and nourishment of marsh areas. The restoration and nourishment of marsh could result in an indirect impact that could be beneficial to soils identified as prime and unique farmlands. The restoration of marsh would contribute to flood attenuation from small storm events and could prevent future loss of prime and unique farmland soils that may be present on nearby chenier ridges.

- *Shoreline Protection*: The Holley Beach shoreline stabilization measure would include placement of rock breakwaters, resulting in direct impacts to approximately 46,000 linear feet of water bottoms in the Gulf of Mexico. The Gulf shoreline restoration would be constructed in three segments, resulting in direct impacts to approximately 139,400 linear feet of water bottoms in the Gulf of Mexico. The fortification of spoilbanks along Freshwater Bayou would consist of bankline protection with rock dikes along three separate reaches, resulting in direct impacts to approximately 81,500 linear feet of water bottoms in Freshwater Bayou. In all shoreline protection measures, soft surface water bottoms would be replaced with rock resulting in indirect impacts to aquatic habitat along the shorelines. Hydric soils could be directly impacted during the placement of stone breakwaters and rock dikes, but long term indirect impacts would include the prevention of further erosion and loss of these soils, and potentially an increase in hydric soils along the Gulf shoreline. Soils associated with prime and unique farmlands are most common on chenier ridges, and none of these soils were identified in the vicinity of the Gulf shoreline restoration or Freshwater Bayou features. Approximately 549 acres of Hackberry loamy fine sand, classified as a prime farmland soil, is located along the shoreline adjacent to the Holley Beach shoreline stabilization feature. The 549 acres of prime farmland soils along the shoreline at Holley Beach would not be directly impacted by the placement of the rock breakwaters, nor would any other prime and unique farmlands be directly impacted or removed from agriculture use

by the shoreline protection feature of the TSP. Indirect impacts to the 549 acres of Hackberry loamy fine sand resulting from the shoreline stabilization feature at Holley Beach would include a reduction in erosion and loss of the prime farmlands.

- *Cheniers*: A total of 578 acres of hydric soils (Table 3-2) were identified along the cheniers. Reforestation of the cheniers would stabilize soils and could prevent future erosion and loss of hydric soils. Therefore, the direct and indirect impacts to hydric soils on the cheniers would be beneficial. No water bottoms were identified on the cheniers, so there would be no direct or indirect impacts to water bottoms as a result of chenier reforestation. Soils that are suitable for agriculture and pastureland in the Chenier Plains are most commonly located on the chenier ridges. Approximately 514 acres of soils classified as prime farmlands, consisting entirely of Hackberry loamy fine sand, are present along the chenier ridges that are proposed for reforestation under this alternative. The reforestation of the chenier ridges would remove these areas and identified prime farmlands from future agricultural use. In compliance with the Farmland Protection Policy Act (FPPA), the USACE would consult with the Department of Agriculture – Natural Resources Conservation Service (NRCS) to determine the precise acreage that would be impacted.
- *Oyster Reefs*: Preservation of the existing historic oyster reef in Sabine Lake would have no direct impacts to soils, water bottoms, or prime and unique farmlands. The preservation of the oyster reef is an effective technique for controlling salinity and limiting saltwater intrusion into wetlands. A beneficial indirect impact would be the preservation of hydric soils and wetlands adjacent to Sabine Lake.

Alternative - Mermentau Small Integrated Restoration Plan

Impacts are the same as the MB component of the TSP; there are no oyster reef restoration measures in the MB.

3.3.1.3 Coastal Shorelines

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches

No impacts as the NED areas are located far removed from the Gulf coastal shoreline.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: No impacts.
- *Marsh Restoration*: Only the marsh restoration feature at Mud Lake (124c) would occur in proximity to the Gulf shoreline. Construction of this measure would require dredged material to be pumped across the shoreline from the Gulfborrow site to the marsh restoration sites resulting in only temporary and minor disturbance to the shoreline resources expected from this construction activity.
- *Shoreline Protection*: Proposed segmented breakwaters are expected to eliminate or substantially reduce erosion of the gulf shoreline, but would not directly affect hydrology or salinity levels since the openings between the breakwater segments would allow free passage of water. Indirectly, the breakwaters would maintain existing salinity and hydrology in the marshes and water bodies behind the shoreline, which could otherwise be altered by continued erosion. In the MB there are numerous canals and natural bayous and ponds that lie behind the gulf shoreline. Gulf shoreline restoration measures (6b1, 6b2, and 6b3) would prevent new openings from forming between the Gulf and these water bodies.
- *Cheniers*: Several of the chenier restoration projects would occur in close proximity to the Gulf shoreline. It is possible that some construction equipment may be delivered by barge from the Gulf to access the chenier ridges to perform restoration activities. In such cases,

there would be minor, localized, temporary adverse impacts, including loss of vegetation cover and displacement of shoreline sediments.

- *Oyster Reefs*: No impacts.

Alternative - Mermentau Small Integrated Restoration
Direct and Indirect Impacts: Impacts same as MB impacts of TSP.

3.3.1.4 Vegetation Resources

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)
The eleven reaches within the area identified as the nonstructural component of the TSP would not significantly impact existing vegetation resources as any construction would be to previously disturbed areas. There is a risk that certain methods at certain locations could impact wetlands on that site but these methods and locations combinations would be avoided where practicable.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
The TSP would restore/nourish/protect a total of about 7,315 acres in the CB; and 16,868 acres in the MB.

- *Hydro/Salinity*: Measure #74a in the CB would provide benefit to approximately 1,395 acres of existing wetlands through the evacuation of wetland-damaging storm surge-deposited water from behind the Cameron-Creole levee during storm events. However, this measure is not anticipated to affect daily tidal exchange from Calcasieu Lake. There is a potential that it could do more harm than good. Measure #13 in the MB would provide benefit to approximately 2,791 acres of existing wetlands by reducing saltwater intrusion and tidal flux from the lower Mermentau River into the wetlands adjacent to Little Pecan Bayou south of Grand Lake in the MB through freshwater introduction and construction of a retention structure or sill on Little Pecan Bayou. Together these measures would indirectly benefit aquatic organisms by reducing the existing rapid changes in salinities and moderate the hydrologic flux of these systems thereby providing for a more stable system.
- *Marsh Restoration*: These measures would restore and/or nourish a net total of approximately 2,083 acres of saline marsh and 1,905 acres of brackish marsh in the CB and 4,726 acres of brackish marsh in the MB. Of these totals approximately 9 acres of saline marsh and 10 acres of brackish marsh would be impacted in the CB, and approximately 67 acres of brackish marsh would be impacted in the MB from access required for borrow deposition. More detail on the benefits derived from the marsh restoration features can be found in table 1-13. Restored/nourished marsh would contribute to reducing the overall habitat fragmentation in the area as well as provide many different species of fish and wildlife with shelter, nesting, feeding, roosting, cover, nursery, and other life requirements habitat. These marsh habitats will also provide neotropical migrants with essential staging and stopover habitat (after Stoffer and Zoller 2004, Zoller 2004).
- *Shoreline Protection*: These measures would protect a net total of approximately 26 acres of barrier island habitat in the CB, and 4,821 acres of saline marsh and 1,288 acres of brackish marsh in the MB. These shoreline protection measures would restore an important geomorphic framework for preventing further fragmentation and loss of interior wetlands used as habitat by many different species of fish and wildlife.
- *Cheniers*: Measures would provide reforestation of Chenier forests and improve a net total of 426 acres of habitat in the CB and 242 acres of habitat in the MB. The proposed reforestation would provide critical stopover habitat for migratory neotropic birds.
- *Oyster Reefs*: This measure would preserve the historic Sabine Lake oyster reef located in the southern end of Sabine Lake near Sabine Pass in the CB. Preservation of this oyster

reef would provide a major structural component of the Sabine Lake estuary and support more animal life than any other portion of the sea bottom (Bahr and Lanier 1981; Meyer and Townsend 2000; Nelson et al. 2004; Tolley and Volety 2005; Tolley et al. 2005; Boudreaux et al. 2006). In addition to increasing species richness, the preservation of this three-dimensional structure will help stabilize and buffer adjacent shorelines from high wave energy (after Smithsonian 2001).

Alternative - Mermentau Small Integrated Restoration
Impacts are the same as the MB component of the TSP.

3.3.1.5 Wildlife Resources

HSDRR (NED) Plans

Alternative - Nonstructural Plan (TSP)
No significant impacts on most wildlife resources except for human commensal wildlife (e.g., rats, mice, pigeons, etc.) which thrive in association with human habitations which typically disrupt the natural habitats. There could be possible benefits to wildlife if enough structures on land contiguous with each other were bought out and allowed to return to a natural state and if that area was contiguous with an adjacent wildlife corridor.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: The loss of fresh marsh attributed to salinity intrusion from daily tidal movement as projected within areas controlled by these proposed structures would be largely eliminated helping to preserve the existing marsh in the area and the wildlife populations dependant on this habitat type. No wildlife impacts are anticipated from installation of these structures.
- *Marsh Restoration*: Approximately 2,542 acres of open water would be converted to brackish marsh, and 3,025 acres to saline marsh in the CB, and approximately 4,362 acres of open water would be converted to brackish marsh in the MB. Additional nourishment could occur adjacent to the marsh restoration sites. The proposed restoration/nourishment in these basins would result in improved habitat conditions for several species of wildlife including migratory and resident waterfowl, shorebirds, wading birds, and furbearers. Migratory waterfowl utilizing the area would benefit from a greater food supply resulting from the increased abundance and diversity of emergent and submerged species. Habitat for the resident mottled duck would also improve considerably as the marsh platform would provide more desirable nesting habitat. Intertidal marsh and marsh edge would also provide increased foraging opportunities for shorebirds and wading birds. Small fishes and crustaceans are often found in greater densities along vegetated marsh edge (Castellanos and Rozas 2001, Rozas and Minello 2001), and many of those species are important prey items for wading birds such as the great blue heron, little blue heron, great egret, black-crowned night-heron, and snowy egret. Mudflats and shallow water habitat restored by the deposition of dredged material would provide increased foraging opportunities for shorebirds such as least sandpipers, killdeer, and the American avocet. Those species feed on tiny invertebrates and crustaceans found on mudflats which are exposed at low tide and in shallow-water areas of the appropriate depth. Furbearers (such as nutria and muskrat) which feed on vegetation would benefit from the increased marsh acreage in the project area. Representative furbearers such as the mink, river otter, and raccoon have a diverse diet and feed on many different species of fishes and crustaceans. Those species often feed along vegetated shorelines which provide cover for many of their prey species. The loss of open water habitat with construction of these features would not be expected to adversely affect species that currently utilize these habitats as there is ample open water habitat in the

basins. Wildlife species currently utilizing the shallow open water and vegetated shorelines in the project area are highly mobile and/or suited to semi-aquatic life and should not be affected during construction.

- *Shoreline Protection*: The installation of approximately 186,000 ft of segmented offshore breakwaters and 81,500 ft rock revetment would work to protect the marshes behind these structures from wave induced erosion and help maintain wildlife populations dependent on this habitat type. Some habitat would be lost during installation of the rock revetment reducing the available habitat for wildlife species and resulting in the demise of more immobile wildlife species. However, these impacts would result in a minimal overall impact to wildlife populations in the area and would work to protect the adjacent habitat these species depend on for survival that could be lost in the future if the revetment not installed.
- *Cheniers*: Approximately 426 acres of existing Chenier habitat in the CB and 242 acres of existing Chenier habitat in the MB would undergo invasive species control and reforestation with construction of the proposed action. Implementation of these measures wouldincrease the diversity of the existing habitat and the quality of the available foraging, resting and nesting habitat necessary for numerous terrestrial and avian wildlife species and essential for neotropical migrants. Construction would be minimally invasive (no earthwork is required) and some species may temporarily avoid these project features during construction, but would quickly return once construction is complete.
- *Oyster Reefs*: Oyster reefs provide major structural components of estuaries and support more animal life than any other portion of the sea bottom (Bahr and Lanier 1981; Meyer and Townsend 2000; Nelson et al. 2004; Tolley and Volety 2005; Tolley et al. 2005; Boudreaux et al. 2006). The total number and densities of fish, invertebrate and algal species greatly increase in areas containing oyster reefs (Bahr & Lanier 1981). More than 300 marine invertebrate species may occupy an oyster reef at one time (Wells 1961). Many of the marine organisms attracted to oyster reefs are also used by seabirds, shorebirds, piping plovers, pelicans, marine mammals, and sea turtles as source of food. In addition, the three-dimensional structure of the reef provides other services such as stabilizing and buffering shorelines from high wave energy (Smithsonian 2001) which provide beach, dune, and back barrier marsh habitats to a wide variety of wildlife species.

<u>Alternative - Mermentau Small Integrated Restoration</u>
Impacts to wildlife resources would be similar to those discussed for the NER TSP except to a lesser extent.

3.3.1.6 Fisheries and Aquatic Resources

HSDRR (NED) Plans

<u>Alternative - Nonstructural Justified Reaches (TSP)</u>
The nonstructural features should have no impact to these resources depending on the methods used. Direct and indirect impacts to these resources will be refined when the actual method of nonstructural and number of structures are examined in future NEPA documents.

Ecosystem Restoration (NER) Plans

<u>Alternative - Comprehensive Small Integrated Restoration Plan (TSP)</u>

- *Hydro/Salinity*: The CB component (#74a) as presently described would convert approximately 7 acres open water benthic habitat and 0.25 acres of marsh into a rock structure, part of this structure would be out of the water and would be completely unavailable for fisheries use. The majority of the open water area is now listed a public oyster seed ground. The MB component (#13) would directly impact approximately 0.40 acres of benthic habitat and neck down the bayou and limit organism access to marsh and open-water areas behind the structure. This measure may also change the species profile

behind structure by both the physical limitation of access and the freshening of the area. Direct effects on benthic habitat from both measures include covering and smothering of benthic organisms including oysters by the placement of rock. During construction of project features, there would be short-term indirect adverse impacts to plankton, benthic populations and fisheries species due to increases in turbidity, low dissolved oxygen, and introduction of sediments into shallow open water areas. Filter feeding species would be impacted due to clogging of the gills which could either cause death or reduce growth and reproduction. Visual predators would have a reduced success rate due to turbidity. Mobil species would attempt to move from the area of influence.

- *Marsh Restoration*: Impacts in the construction footprint (CB over 6,000 acres and MB over almost 6,550 acres restored or nourished), and construction activities using earthen materials to create wetland could include the elimination of benthic, oyster, and fishery habitat or the conversion of shallow open water habitats to less valuable deep water borrow areas, and direct mortality or injury of fisheries and benthic species due to burial or increased turbidity. Approximately 9,100 acres are identified for borrow (3,300 acres from Calcasieu Ship Channel, 5800 acres Gulf) Depending on the depth of the borrow canal this deeper water habitat could provide a refuge for during extreme water temperature spike. Improved marsh habitats and increased SAV could have positive indirect impacts on juvenile fishes, shrimp, crabs, and other species by increasing food and cover if they are able to access the area. The conversion of open water to marsh is generally considered a benefit to aquatic species.
- *Shoreline Protection*: Impacts in the construction footprint (CB/ 24.4 and MB/72.96 acres of segmented offshore break water) would include the elimination of benthic, oyster, and fishery habitat and would cause the conversion of sandy shallow open water habitats to rock habitat which will only partially be submerged. Additionally 63.63 acres of shallow mud bottom would be converted to rock with the MB components in the GIWW and Freshwater Bayou. During construction of project features, there would be short-term indirect adverse impacts to plankton, benthic populations and fisheries species due to increases in turbidity, and low dissolved oxygen. Filter feeding species would be impacted due to clogging of the gills which could either cause death or reduce growth and reproduction. Visual predators would have a reduced success rate due to turbidity. Mobil species would attempt to move from the area of influence. Rock substrate is known to provide benefits to some aquatic species by providing them a refuge from predation. They also provide a hard substrate for oyster spat to settle on.
- *Cheniers*: Reforestation of the Chenier ridges would have no direct, indirect or cumulative impacts on these resources.
- *Oyster Reefs*: The active preservation of oyster reefs will overtime provide a net indirect and cumulative positive impact to these resources by limiting the loss of limited habitat type. There would be no direct impacts to aquatic and fisheries species.

<u>Alternative - Mermentau Small Integrated Restoration Plan</u>
Impacts are the same as the MB component of the TSP.

3.3.1.7 Essential Fish Habitat (EFH)

HSDRR (NED) Plans

<u>Alternative - Nonstructural Justified Reaches (TSP)</u>
No significant impact to these resources are expected. There is a risk that certain methods at certain locations could impact wetland EFH on that site but these methods and locations combinations would be avoided where practicable.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Measure #74a in the CB would directly impact water bottom EFH by converting approximately 7 acres into rocky bottom and 0.25 acres of marsh EFH into a rock structure. Additionally measure MB #13 would impact 0.40 acres water bottom EFH in the same way, and would restrict the bayou and limit organism access to approximately 2,791 acres of marsh and open-water EFH. Rock is not considered EFH in coastal Louisiana.
- *Marsh Restoration*: Both the CB and MB components would convert over 4,400 acres and almost 4,150 acres of open water (combination of estuarine mud bottoms and oyster reefs EFH) respectively to marsh (marsh edge, SAV, marsh ponds, and inner marsh EFH). Construction activities using earthen materials to create marsh could bury EFH substrates or temporarily change environmental conditions, including turbidity and salinity, in the water column. The project would increase SAV and adjacent intertidal marsh vegetation (marsh restoration areas) in some areas. The CB components and MB components will nourish over 1,600 acres and almost 2,400 acres, respectively, of existing marshes and terraces. This will be a long term indirect positive impact to marsh (marsh edge, SAV, marsh ponds, and inner marsh EFH). Approximately 9,100 acres are identified for borrow (3,300 acres from Calcasieu Ship Channel, 5800 acres Gulf for the CB) If the dredged material coming from the ship channel is coming during a maintenance event there would be no additional impacts to EFH. Borrow from the Gulf would convert Gulf water EFH to a deeper depth Gulf water EFH. Some of the offshore borrow areas could refill with material overtime.
- *Shoreline Protection*: Both the CB and MB components would convert almost 25 acres and 140 acres of open water (combination of estuarine mud bottoms, oyster reefs, Gulf waters, marsh edge, offshore, beach, coastal, and sand EFH) respectively to rock which is not considered EFH in coastal Louisiana.
- *Cheniers*: Reforestation of the Chenier ridges would have no direct, indirect or cumulative impacts on EFH.
- *Oyster Reefs*: The active preservation of oyster reefs will overtime provide a net indirect and cumulative positive impact to EFH by limiting the loss of oyster reef habitat. There would be no direct impacts to EFH.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts same as the MB component of TSP.

3.3.1.8 Threatened and Endangered Species, and Other Protected, Species of Concern HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)
This alternative would not adversely impact the success of the red-cockaded woodpecker (RCW) or any other listed species or the success of any species of concern within the project area. Direct impacts would be avoided in accordance with the Endangered Species Act (ESA), Marine Mammals Protection Act, Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act by the use of best management practices (BMPs) (see appendix A) and recommendations from USFWS and NMFS. Depending on final designs of the NED TSP, potential minimal indirect impacts could occur to the listed RCW and the candidate species, Sprague's pipit. These impacts could include the disturbance of any foraging or nesting birds due to construction activity and noise. This disturbance could force any RCWs and Sprague's pipit to seek foraging and/or nesting grounds in surrounding areas which offer suitable habitat. However, impacts to these listed species would be avoided, minimized and reduced to the maximum extent practicable and mitigated as necessary.

Species of Concern: Depending on final designs of the NED TSP, there could be a potential for minimal indirect impacts to colonial nesting water birds. These impacts could include the

disturbance of roosting or foraging birds due to construction activity and noise. It is assumed the birds would relocate to adjacent foraging/roosting grounds. Nesting birds would not be impacted as no work would take place within a rookery. Additionally, during nesting season, work would be required to take place outside of the USFWS and LDWF-declared buffer zones (appendix A annex K). Work within the buffer zones may only take place during non-nesting season (September 1 to February 15). There would be no impacts to the bald eagle as no known nests are located near any project features. If an eagle's nest is sighted within the project area, a no-work zone would be implemented (appendix A annex K).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Direct impacts would be avoided in accordance with the ESA, BGEPA, MMPA and MBTA by the use of BMPs (appendix A annex K) and recommendations from USFWS and NMFS. All indirect impacts would be avoided, minimized and reduced to the maximum extent practicable and mitigated as necessary. Further consultation will occur as this project moves forward.

- *Hydro/Salinity*: No anticipated impacts to T&E.
- *Marsh Restoration*: Potential temporary minimal indirect impacts to the West Indian manatee, Gulf sturgeon and all sea turtles identified in Chapter 1. In addition critical habitat for piping plover will be impacted by the dredge pipeline coming in from the Gulf where it crosses the beach. Timing of placement and removal of the pipeline will be coordinated with USFWS. Temporary construction related impacts would result from noise, turbulence and the mere presence of workers in the marsh restoration sites, access routes and borrow sites and would likely result in the species avoiding the area temporarily. Beneficial impacts would be the increase in wetland habitat which is utilized by the Whooping crane.
- *Shoreline Protection*: Potential Indirect impacts to the West Indian manatee, Gulf sturgeon and all sea turtles listed in appendix A annex K would be temporary and minimal. Temporary construction related impacts would be due to noise, turbulence and mere presence of workers in the marsh restoration sites, access routes and borrow sites and would likely result in the species avoiding the area temporarily. Permanent impacts would be the hindrance of access by sea turtles, to thousands of linear feet of shoreline. Although, it is assumed that they could easily go around the breakwater as it would not be continuous. Indirect beneficial impacts would be the protection of thousands of linear feet of shoreline which is designated piping plover critical habitat and also used by the Red knot.
- *Cheniers*: There could be potential minimal indirect impacts to the Sprague's pipit if reforestation of grasslands would occur. It is assumed that the bird would relocate to an adjacent or nearby suitable foraging/roosting area.
- *Oyster Reefs*: Oyster reef preservation could benefit the Red Knot as they have been observed foraging on oyster reefs.

Species of Concern:

- Potential for minimal indirect impacts to colonial nesting water birds. Impacts could include disturbance of roosting or foraging birds due to construction activity and noise. It is anticipated nesting birds would not be impacted as no work would take place within a rookery. Additionally, during nesting season, work would be required to take place outside of the USFWS and LDWF declared buffer zones (appendix A). Work within buffer zones may only take place during non-nesting season (September 1 to February 15). In addition to these potential adverse impacts, marsh restoration would beneficially impact colonial nesting water birds by providing additional foraging grounds.
- No impacts to the bald eagle, as no known nests are located near any project features. If an eagle's nest is found within the project area, a no-work zone must be implemented.

- Bottlenose dolphins could be found in the vicinity of these project features, but with the utilization of the measures for reducing entrapment of this species found in appendix A, no indirect impacts are anticipated.

Alternative - Mermentau Small Integrated Restoration Plan
Impacts to T&E resources would be similar to those discussed for the NER TSP except to a lesser extent.

3.3.1.9 Cultural and Historic Resources

The following alternatives have the potential to impact cultural resources, and CEMVN has determined that additional investigations would be required to locate and define the boundaries of cultural resources within the area of potential effects (APE) for the TSP. Cultural resources investigations would also include eligibility determinations for archaeological sites and historic standing structures located within the APE. The information provided below is based upon a preliminary review of cultural resources literature and records maintained by the Louisiana Division of Archaeology and the Division of Historic Preservation. CEMVN has initiated Section 106 consultation, and the APE, research design and survey methodology will be determined through consultation with the Louisiana State Historic Preservation Officer, federally recognized Indian Tribes, and additional consulting parties. The results of the identification and evaluation of historic properties will be coordinated with the Louisiana SHPO, Tribes, and additional consulting parties, and the CEMVN will seek to identify ways to avoid, minimize, and/or mitigate impacts to historic properties and resources of religious and cultural significance to Tribes that have the potential to be impacted by the proposed action.

HSDRR (NED) Plan

Alternative - Nonstructural Justified Reaches (TSP)
There is the potential for direct and indirect impacts to previously recorded archaeological sites and standing structures with a minimum age of 50 years, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation. Approximately 26,000 standing structures located within the 100-year flood plain have been identified as candidates for nonstructural measures. Although specific structures have not been selected for nonstructural measures, thousands of standing structures that have been identified as potential candidates have a minimum age of 50 years and have not been assessed for eligibility. Fourteen historic properties have been identified in Calcasieu Parish, including ten that are listed in the National Register of Historic Places (NRHP). An additional two historic properties listed in the NRHP have been identified in Vermilion and Iberia parishes.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)
CB - There is the potential for direct and indirect impacts to eighteen previously recorded archaeological sites and forty-eight standing structures with a minimum age of 50 years that have not been assessed for eligibility, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation. The previously recorded sites include one potentially eligible for listing in the NRHP and four that have been determined not eligible for listing in the NRHP. The remaining thirteen have not been assessed. Of the eighteen, thirteen have prehistoric components, and six have historic components.

- *Hydro/Salinity*: No previously recorded sites or standing structures have been identified within a one-mile buffer of the proposed measure (#74a).
- *Marsh Restoration*: One prehistoric site of unknown eligibility has been identified within a one-mile buffer of the proposed measures (3a1, 3c1, 124c, 124d). No previously recorded

standing structures have been identified within a one-mile buffer of the proposed measures. No previously recorded sites have been identified within the proposed borrow areas.

- *Shoreline Protection*: One historic site that has been determined not eligible for listing in the NRHP has been identified within a one-mile buffer of the proposed measure (5a). Four previously recorded standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.
- *Cheniers*: Twelve prehistoric sites, one with a historic component, and four historic sites have been identified within a one-mile buffer of the proposed measures (416, 510a, 510b, 510d), one of which has been identified as potentially eligible for listing in the NRHP and three that have been determined not eligible for listing in the NRHP. The remaining twelve have not been assessed. Forty-four previously recorded standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.
- *Oyster Reefs*: No previously recorded sites or standing structures have been identified within a one-mile buffer of the proposed measure (604).

MB - There is the potential for direct and indirect impacts to twenty-six previously recorded archaeological sites and thirty-one standing structures with a minimum age of 50 years that have not been assessed for eligibility, as well as any unrecorded sites and/or standing structures that may be identified during the cultural resource investigation. The previously recorded sites include two potentially eligible for listing in the NRHP and seven that have been determined not eligible for listing in the NRHP. The remaining eighteen have not been assessed. Of the twenty-six sites, twenty-four have prehistoric components, and three have historic components.

- *Hydro/Salinity*: Four prehistoric sites have been identified within a one-mile buffer of the proposed measure (#13), one of which has been identified as potentially eligible for listing in the NRHP and three that have not been assessed. No previously recorded standing structures have been identified within a one-mile buffer of the proposed measure.
- *Marsh Restoration*: Nine prehistoric sites have been identified within a one-mile buffer of the proposed measures (47a1, 47a2, 47c1, 127c3, 306a1), one of which has been identified as potentially eligible for listing in the NRHP and two that have been determined not eligible for listing in the NRHP. The remaining six have not been assessed. Fifteen standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility. No previously recorded sites have been identified within the proposed borrow areas.
- *Shoreline Protection*: Eight prehistoric sites have been identified within a one-mile buffer of the proposed measures (16b, 6b1, 6b2, 6b3), four of which have been determined not eligible for listing in the NRHP. The remaining four have not been assessed. No previously recorded standing structures have been identified within a one-mile buffer of the proposed measure.
- *Cheniers*: Twelve prehistoric sites, one with a historic component, and two historic sites have been identified within a one-mile buffer of the proposed measures (416, 509c, 509d, 510d), one of which has been identified as potentially eligible for listing in the NRHP and three that have been determined not eligible for listing in the NRHP. The remaining ten have not been assessed. Thirty-one standing structures within the one-mile buffer have a minimum age of 50 years and have not been assessed for eligibility.
- *Oyster Reefs*: No previously recorded sites or standing structures have been identified within a one-mile buffer of the proposed measure (604).

<u>Alternative - Mermentau Small Integrated Restoration</u>
Impacts would be the same as those described for the MB component of the TSP.

3.3.1.10 Aesthetics (Visual Resources)

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

Minimal impacts to visual resources. The raising of homes would not impact view sheds into any surrounding areas. In cases where a home or land buyout may be taking place this could indirectly impact visual resources by removing the viewer from a given area. In areas where there is public access from a street or roadway, these non-structural elements would not change the view shed. Houses being raised are currently present, their elevation would change, but the site is still occupied either way. In the case of a home buyout, if a home is removed and open land is created, then this could be considered as a benefit to drivers looking for natural scenery or a loss to an established neighborhood.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: In terms of technical significance, reducing the flow of salinity excesses and increasing wetland productivity, visual resources would most certainly see a benefit. In those areas where these measures would take place, open water areas would grow into healthy marshes, bringing more texture, color and framing elements to the landscape. Greater habitat diversity would be achieved, bringing a greater variety of fauna to the given area to serve as focal points of life. In terms of public and institutional significance, the measures associated with hydro/ salinity will positively benefit areas in Cameron Parish along the Creole Nature Trail Scenic Byway and All American Road. Those areas project designated areas along State Highways 27 and 82 will be directly visible to those travelling the scenic byway.
- *Marsh Restoration*: This element would not be all that different from the definitions listed under Hydro/ Salinity. The areas of significance, in terms of what Hydro/ Salinity goals are meant to achieve, are almost exactly the same as they relate to Visual Resources. The primary difference is in how the marsh is restored. With the use of beneficial use dredge material from Calcasieu Ship Channel, where impacts will be minimal, visual resources will be greatly and positively impacted. Those areas along the Creole Nature Trail will positively impact the byway creating enhanced view sheds for travelers. Other areas, such as that located along the Intracoastal waterway and Freshwater Bayou Canal have less visual significance because those areas are remote with limited access.
- *Shoreline Protection*: These elements do have public visual significance and their protection and restoration would add an element of form, line and color to the shoreline of Louisiana. However; many of these areas are remote and public access is severely limited.
- *Cheniers*: Visually, these features are the most significant of any other in the study area. Cheniers aid in the form and function of developing the design elements of the landscape. As small hillocks or mounds, they offer the variation in terrain that makes the view shed interesting and memorable. They offer islands of oasis for different plant materials to develop and add texture and color to the land. In most cases, they allow taller trees to grow in a region which adds the necessary framing elements to the landscape to give it artistic quality and character. Most of the designated chenier restoration features are located directly adjacent to the Creole Nature Trail and would drastically and positively add to design elements already described under marsh restoration and hydro/ salinity.
- *Oyster Reefs*: These elements have little to no technical, public or institutional significance in terms of Visual Resources. However; it could be imagined that oyster reefs would create areas of diverse habitat. Elements of design, seen by the naked eye of the viewer would be limited. These sites are remote and public access is limited..

Alternative - Mermentau Small Integrated Restoration

Impacts would be the same as those described for the MB component of the TSP.

3.3.1.11 Recreation

HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

A direct impact from the acquisition of structures includes potentially reducing the number of recreational camps. On the other hand, the vacated sites would become open space that could be used recreationally. There are no direct impacts from structure elevation on recreational resources. A direct impact from flood proofing park buildings is the recreational use will be temporarily unavailable during flood proofing activities. An indirect impact from elevating structures on building costs of future recreational camps could result in fewer camps being constructed.

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

- *Hydro/Salinity*: Direct impacts include restricting boaters' access to recreational resources in the area during construction activities. By reducing saltwater intrusion into adjacent wetlands, levels of recreational fishing and hunting should be maintained and even improved as wetland acreages increase.
- *Marsh Restoration*: Any direct impacts to recreational fishing, hunting and other recreational resources would be temporary and occur during construction activities. Recreationalists may have to circumvent the marsh restoration project area when traveling to a destination due to construction activities limiting or delaying access. In general, measures that create marsh habitat and improve hydrology of wetlands are more likely to improve recreational fishing opportunities by enhancing the sustainability of productive nursery habitats.
- *Shoreline Protection*: Any direct impacts to recreational fishing and hunting would be temporary and occur during construction activities. SP projects should help protect recreational resource lands from effects of coastal storm surge and minimize the loss of valuable fishery habitat.
- *Cheniers*: Restoration of natural ridges would improve bank stabilization and potentially provide additional habitat for deer, small game and birds, which could be beneficial for hunting and bird watching. Restored ridges would also enhance protection of adjacent swamps and marshes during coastal storms, which could also potentially benefit recreational resources and infrastructure such as boat launches.
- *Oyster Reefs*: There are no direct impacts on recreational resources. Public oyster grounds are located within the oyster reef restoration area. However, oyster seasons in Sabine Lake haven't occurred since the early 1960's based on anecdotal information; neither Texas nor Louisiana can document harvest beyond that time and no concrete harvest data has been located (LDWF 2012 Oyster Stock Assessment Report of the Public Oyster Areas in Louisiana). Since oyster reef restoration measures improve the hydrology of wetlands, there could be an indirect impact on recreational resources from improved wetland habitat.

*For additio*nal information on direct and indirect impacts of the TSP on recreational resources, see the Recreation Appendix (appendix A).

Alternative - Mermentau Small Integrated Restoration

Impacts would be the same as those described for MB component of the TSP.

3.4 Cumulative Impacts

3.4.1.1 HSDRR (NED) Plans

Alternative - Nonstructural Justified Reaches (TSP)

Cumulative impacts are the effects on the environment that result from the incremental impact of the proposed project when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (Federal or non-Federal) or person undertakes such actions. Cumulative impacts can result from actions that individually are minor, but collectively result in significant actions taking place over time (Section 1508.7 40 CFR Parts 1500-1508). For example, the incremental impacts of emergent wetland restoration at several localized areas could significantly modify an entire basin's habitat diversity. A determination was made utilizing CEQ's 11-step cumulative effects analysis process.

HSDRR (NED) Plans

Alternative - Nonstructural Plan (TSP)

Cumulative impacts would be the incremental direct and indirect effects on each significant resource described above, caused by elevating 3,665 residential structures, flood proofing 247 non-residential structures and acquiring 3 residential structures for acquisition. These incremental impacts would be in addition to the direct and indirect impacts attributable to other existing and authorized for construction HSDRRS throughout the Sabine, Calcasieu, Mermentau and Teche-Vermilon basins; the State and the Nation. The proposed action incremental effects would be in addition to the State's approximately 3,122 miles of levee (source: http://www.infrastructurereportcard.org/louisiana/louisiana-overview/); and the approximately 100,000 miles of levees which exist throughout the Nation (source: http://www.infrastructurereportcard.org/levees/). At this time there are very few of these plans that have nonstructural components. These impact on all resources need to be combined with The Federal Emergency Management Agencies' Hazard Mitigation Assistance (HMA) program (http://www.fema.gov/hazard-mitigation-assistance). The HMA) grant programs provide funding for eligible mitigation activities that reduce disaster losses and protect life and property from future disaster damages. Currently, FEMA administers the following HMA grant programs:

- Hazard Mitigation Grant Program (HMGP) HMGP assists in implementing long-term hazard mitigation measures following Presidential disaster declarations. Funding is available to implement projects in accordance with State, Tribal, and local priorities.
- Pre-Disaster Mitigation (PDM) PDM provides funds on an annual basis for hazard mitigation planning and the implementation of mitigation projects prior to a disaster. The goal of the PDM program is to reduce overall risk to the population and structures, while at the same time, also reducing reliance on Federal funding from actual disaster declarations.
- Flood Mitigation Assistance (FMA) FMA provides funds on an annual basis so that measures can be taken to reduce or eliminate risk of flood damage to buildings insured under the National Flood Insurance Program (NFIP).

Ecosystem Restoration (NER) Plans

Alternative - Comprehensive Small Integrated Restoration Plan (TSP)

Cumulative impacts would primarily be related to the incremental impact of all past, present, and future actions affecting multiple resources. The incremental effects of the project would enhance aquatic resources when combined with other Federal, state, local, and private restoration efforts. Cumulative impacts would be the incremental direct and indirect effects on each significant resource described above of restoring over 6,000 acres of wetlands impacted by saltwater intrusion and inundation via hydrology/salinity control structures; over 8,700 acres of marsh restoration and nourishment; over 5,500 acres (almost over 266,900 linear feet) of shoreline protection; over 1,400 acres of chenier restoration; and preservation of the Sabine Lake oyster reef. Proposed action incremental effects would be in addition to the direct and indirect effects of other ecosystem restoration efforts throughout the Sabine, Calcasieu, Mermentau and Teche-Vermilion basins; the State and the Nation including:

- CWPPRA program — 151 restoration/protection projects benefiting over 110,000 acres.

- LCA Program — the USACE and the State will continue to partner on the Mississippi River Hydro/Delta Management Feasibility Study. In addition, the State is expected to continue to partner with the USACE on the advancement of the Small Diversion at Convent/Blind River projects (currently in design), and to construct the Caminada Headland component of the Barataria Basin Barrier Shoreline project (currently in design by the State) and Demonstration Projects (currently developing program implementation plans). The State has declined to participate in the LCA BUDMAT program; however, other non-federal cost share sponsors are presently being negotiated
- The 2012 State Master Plan (CPRA 2012) — the State evaluated 248 restoration projects, 33 structural and 116 conceptual non-structural flood risk reduction projects. The State acknowledges that each project has its own timeline and budget.
- There are various other restoration programs including funds from the BP oil spill.

Cumulative impacts would include impacts to visual resources due to the number of acres of marsh, wetland and swamp in the project area and other areas throughout the basin, LA and the nation being reverted from open water back to land mass. Replenishment of the land would convert existing view sheds of open water into marsh, wetland, swamp or a variety of landscape types that frame large bodies of open water and use the basic design elements of form, line, texture, color and repetition to create an aesthetically pleasing view shed.

Similar projects across Southern Louisiana include the Louisiana Coastal Restoration projects, which also include a number of diversion projects, marsh and swamp restoration and nourishment, and shoreline protection; CWPPRA projects that include diversions, marsh restoration, shoreline protection, and siphons; lock replacement projects; and operation and maintenance projects, like that found at Bonnet Carre' Spillway. In addition the LACPR has request permits to construct two new Mississippi River diversions. Other similar projects can be found throughout the nation as both public and private responsibilities. Past, present and future projects of this type are necessary to both maintain existing marsh levels and build up future levels, thereby diminishing open water areas and creating land mass.

Cumulative Impacts: There are other Gulf shoreline protection and restoration projects that have been constructed along the Gulf shoreline through other funding sources. Segmented breakwaters have been constructed under at least two separate projects to the west of the proposed Holly Beach Shoreline Stabilization (5a) measure. The proposed breakwater would provide shoreline protection from the eastern end of the existing breakwaters eastward to the Calcasieu Pass jetty and compliment that existing project. The shoreline where the proposed Holly Beach measure would be built has been nourished with material dredged from the bottom of the Gulf of Mexico to help ensure that shoreline erosion did not compromise Louisiana Highways 27/82. Rock and rip/rap has also been placed at critical locations where shoreline erosion has threatened the highway. The proposed Holly Beach measure is compatible with and would augment these prior efforts. There have been proposals to construct shoreline protection measures along the Gulf shoreline where the proposed Gulf Shoreline Restoration: Calcasieu River to Freshwater Bayou (6b1, 6b2, and 6b3) measures are proposed, but no projects have been constructed.

Recreation: Temporary negative impacts of marsh restoration activities due to increased turbidity and possible boating access issues are mediated by the presence of other productive and popular recreation areas throughout the coastal region of Louisiana. Long-term positive cumulative impacts are expected to occur as restorations measures help protect recreational resource lands from effects of coastal storm surge while improving recreational opportunities by enhancing the sustainability of valuable nursery habitats.

Alternative - Mermentau Small Integrated Restoration
Impacts would be the same as described for the Mermentau Basin component of the TSP.

3.5 Any Irreversible and Irretrievable Commitments of Resources Involved in the Implementation of the tentatively selected Plan

NEPA requires that environmental analysis include identification of "any irreversible and irretrievable commitments of resources which would be involved in the tentatively selected plan should it be implemented." Irreversible and irretrievable resource commitments are related to the use of nonrenewable resources and the effects that the use of these resources have on future generations. Irreversible effects primarily result from use or destruction of a specific resource (e.g., energy and minerals) that cannot be replaced within a reasonable time frame. Irretrievable resource commitments involve the loss in value of an affected resource that cannot be restored as a result of the action (e.g., extinction of a T&E species or the disturbance of a cultural site).

The tentatively selected plan would result in the direct and indirect commitments of resources. These would be related mainly to construction components. Energy typically associated with construction activities would be expended and irretrievably lost under all of the alternatives excluding the no action alternative. Fuels used during the construction and operation of dredging equipment and barges would constitute an irretrievable commitment of fuel resources.
For the tentatively selected plan, most resource commitments are neither irreversible nor irretrievable. The dredging of borrow material is considered reversible although it is anticipated that the natural infilling of the borrow pits may take several years. Benthic communities would be removed and lost along with the sediment during dredging operations. Benthic communities would also take several years to recover. Fish and plankton would be entrained in the dredge during the dredging of the borrow areas. These losses would be irretrievable. However, most impacts to fish and plankton are short term and temporary and would only occur during dredging and construction activities. For example, access channels that would be dredged and retention dikes that are constructed would be restored to natural conditions after construction.

Other impacts including disruption of community cohesion that may have a longer effect can be reduced through appropriate enhancement measures and best management practices. There are no irreversible or irretrievable commitments of resources which would preclude formulation or implementation of reasonable alternatives for this project.

3.6 Relationship between Local Short-Term uses of Man's Environment and the Maintenance and Enhancement of Long-Term Productivity

NEPA Section 102(2)(c)(iv) and 40 CFR 1502.16 requires that an EIS include a discussion of the relationship between short-term uses of the environment and the maintenance and enhancement of long-term productivity. This section describes how the tentatively selected plan would affect the short-term use and the long-term productivity of the environment. For the tentatively selected plan, "short-term" refers to the temporary phase of construction of the proposed project, while "long-term" refers to the operational life of the proposed project and beyond. Chapter 3 of the main report evaluates the direct, indirect, and cumulative effects that could result from the tentatively selected plan.

Construction of the tentatively selected plan would result in short-term construction-related impacts within parts of the project area and would include to some extent interference with local traffic, minor limited air emissions, and increases in ambient noise levels, disturbance of fisheries and wildlife, increased turbidity levels, lower DO, and disturbance of recreational and

commercial fisheries. These impacts would be temporary and would occur only during construction, and are not expected to alter the long-term productivity of the natural environment. The NED/NER tentatively selected plan would assist in the long-term productivity of the 3 Basins ecological community by improving the water quantity, water quality, nutrients, and sediments. This in turn would facilitate the growth and productivity of emergent marsh and the invertebrates, fish, and wildlife that utilize these habitats. The NED/NER tentatively selected plan would also result in enhancing the long-term productivity of the natural communities throughout the region. These long-term beneficial effects would outweigh the impacts to the environment resulting primarily from project construction.

With an increase in the amount wetland habitat and increase in wetland habitat quality, fish populations would experience beneficial impacts. These improvements in productivity would beneficially impact long-term commercial and recreational fishing in the study region.

3.7 Mitigation

Mitigation measures are used to avoid, minimize, or compensate for adverse impacts to environmental resources. The appropriate application of mitigation is to formulate a project that first avoids adverse impacts, then minimizes adverse impacts, and lastly, compensates for unavoidable impacts. The impacts described here are programmatic in nature. Subsequent NEPA documents will continue to evaluate the need for mitigation on site specific project(s) impacts prior to implementation. At this point in the study process, no impacts have been identified that would require compensatory mitigation. In addition, no wildlife mitigation would be required at this time. Direct impacts would be avoided in accordance with the ESA, Marine Mammals Protection Act, Bald and Golden Eagle Protection Act and Migratory Bird Treaty Act by the use of BMPs (see appendix A) and recommendations from USFWS and NMFS. Depending on final designs of the TSP, potential minimal indirect impacts could occur to the listed RCW and the candidate species, Sprague's pipit, and direct impact to critical habitat for piping plover. To reduce fisheries related impacts all clearing and snagging will adhere to the Stream Obstruction and Removal Guidelines (1983). Air quality and noise impacts can be reduced by utilizing heavy machinery fitted with approved muffling devices that reduce noise, vibration, and emissions. A cultural resource monitoring program is recommended during the project implementation. This monitoring will consist of having a qualified archaeologist present during the clearing and snagging process. The purpose of the monitoring is to assure that no previously known or unknown archaeological sites are impacted during the implementation of this project.

4.0 TENTATIVELY SELECTED PLAN (*NEPA REQUIRED)

The NED Tentatively Selected Plan (TSP) is **Alternative Plan 7- Nonstructural Justified Reaches.**

The NER TSP is **Alternative Plan CM-4**.

TSP feasibility design will begin after the SMART Planning Agency Decision Milestone and will be included in the Final Report.

4.1 The National Economic Development (NED) Plan

4.1.1 Description of the NED Tentatively Selected Plan (TSP)

The NED TSP (Alternative Plan 7 – Nonstructural Justified Reaches) consists of nonstructural measures throughout eleven economically justified reaches involving a variety of actions including but not limited to:

1. Elevation of eligible (residential) structures up to a maximum 13 feet (the year 2075 base flood elevation or BFE). Means of elevation can be use of pilings, cinder block chain walls, dirt/fill material, and other methods.

2. Acquisition/buyout of eligible residential structures (and underlying land) that would require raising over 13 feet, are too fragile for elevation, or whose value is less than the cost of elevation. Structures would be demolished, property evacuated and property owners relocated to another site outside of the 100 year floodplain. Property owners would receive fair market value for the property acquired.

3. Physical relocation (lifting and moving) structures (i.e., historic structures) to another location outside of the floodplain.

4. Construction of small floodwalls, ring levees, and berms (3-7 feet high) are constructed and located away from the structure(s) to be protected to prevent the encroachment of floodwaters.

5. Dry flood proofing of eligible commercial and public structures (excluding industrial buildings and warehouses) for flood depths not greater than three feet above the adjacent ground by methods such as sealing the walls of structures with waterproofing compounds, impermeable sheeting (veneer walls) and other materials and covers to protect openings from floodwaters. Note: Warehouses are large structures that store or distribute their contents and industrial facilities are large buildings that contain heavy equipment (wet flood proofing was not considered during this study phase).

6. Non-Federal Sponsor/Governmental promulgation and enforcement of building code requirements that are consistent with and supportive of the purpose and objectives of the NED TSP.

<u>Hydrologic and Economic Evaluation of the TSP</u>

Hydrologic and economic models were run to determine the inundation effects of storms on residential, commercial, and industrial properties in the study area. Hydrologic modeling provided the existing and future hydrologic conditions needed to assess storm surge-related damages. The modeling identified 90 hydrologic reaches throughout the study area, These 90 reaches are characterized by unique relationships between storm surge elevations and frequency. An inventory of structure values, types, and first floor elevations was compiled for all

structures in the 90 reaches which identified approximately of 52,000 structures within the southwest coastal flood zone. Approximately 26,604 structures are located within the 100-year flood plain. Using the inventory of structures in the 100-year floodplain and the results of storm surge modeling, a flood damage analysis model was used to estimate economic damages under the no-action alternative and the potential benefits resulting from the implementation of nonstructural measures.

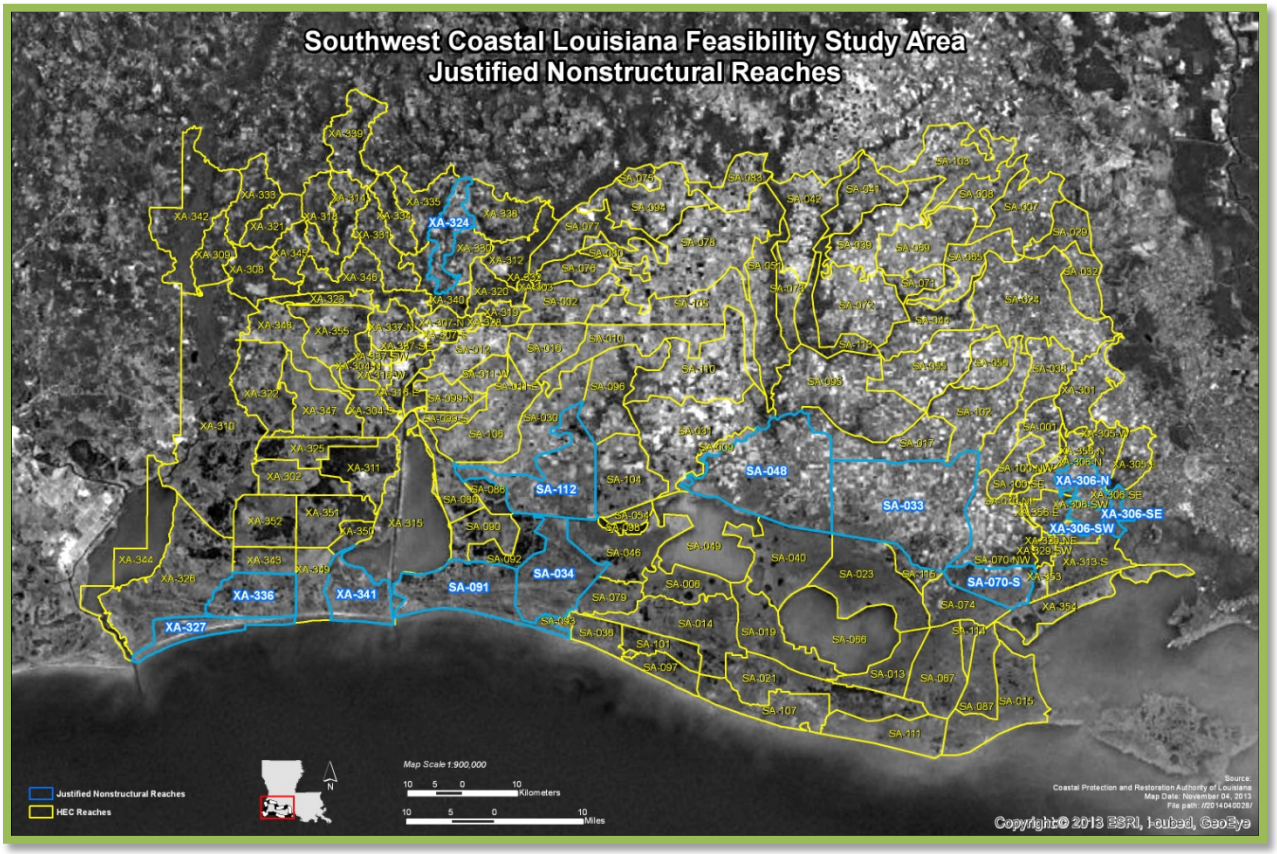


Figure 4-1: Hydrologic reaches.

The economic evaluation employed several assumptions regarding the nonstructural action to be taken for any given structure. Residential structures with first-floor elevations below the 100-year water surface elevation (base flood elevation) were eligible to be raised to the year 2075 base flood elevation. For this evaluation any residence that requires raising by more than 13 feet was identified for acquisition. Non-residential structures with first-floor elevations below the base flood elevation were considered for flood-proofing to a maximum of three feet above the ground. Property owner participation in these nonstructural alternatives is completely voluntary but was assumed to be 100 percent for this evaluation. Implementation details will be refined in the feasibility design phase.

Nonstructural plans were evaluated using the 90 hydrologic reaches that comprise the study area as the unit of analysis. As a result, benefits and costs were calculated on a reach-by-reach basis. In evaluating the entire 90 reach study area it was determined that the benefit-cost ratio for addressing all structures within the 100-year floodplain was 0.54. Eleven reaches were identified as economically justified having a benefit-cost ratio of 1.0 or greater with the ratios for remaining 79 reaches falling below unity. However, significant potential damages were

identified within a number of the non-justified reaches indicating the potential for additional action by other Federal or local entities or programs.

The combined expected annual benefits for addressing all the structures within the floodplain in the justified reaches are $20.67 million. Within the justified reaches, 3,665 residential structures were identified for structure elevation, 247 non-residential structures for flood proofing, and 3 residences for acquisition. The total cost for implementing the nonstructural alternative throughout the justified reaches is slightly over $388 million. The corresponding average annual cost is approximately $16.5 million. Therefore, net benefits for the TSP are $4.17 million and the associated benefit cost ratio is 1.25.

USACE will refine the TSP analyses relating to environmental justice and community cohesion. In addition, the requirement of Executive Order 12898 will be fully incorporated.

4.1.2 Mitigation

No damages to wetland habitats are expected as a result of the implementation of a nonstructural program. Therefore, mitigation for unavoidable impacts from the NED plan implementation is not anticipated to be necessary.

4.1.3 Adaptive Management and Monitoring

Mitigation is not required for the NED TSP and adaptive management will not be required for it.

4.1.4 Operation, Maintenance, Repair, Rehabilitation and Replacement (OMRR&R)

OMRR&R obligations of the NFS for the NED TSP have not been identified at this time but will be refined in the final feasibility report.

4.1.5 Risk and Uncertainty Analysis

Risk and uncertainty are intrinsic in water resources planning and design. This section describes various categories of risk and uncertainty pertinent to the study. Risk and uncertainty will be further considered on the selected alternative during feasibility-level design and analysis.

Environmental Factors

Relative Sea Level Rise (RSLR): There is uncertainty about how much sea level change would occur in the region. An assessment of RSLR was included in plan formulation. The evaluation of RSLR is documented in the Engineering Report and will be refined during feasibility design. Calculations based on EC 1165-2-212 determined that the low, intermediate and high rates of RSLR at 2075 will be 1.47 feet, 2.04 feet, and 3.86 feet higher than current levels respectively (Table 4-1). The intermediate rate was used for models and assessing alternatives.

Table 4-1: Sea level and relative sea level rise values.

Year and SLR Scenario	SLR (NAVD88 feet)	RSLR (NAVD88 feet)
2025 Low SLR	0.16	0.78
2025 Intermediate SLR	0.22	0.84
2025 High SLR	0.40	1.02
2075 Low SLR	0.85	1.47
2075 Intermediate SLR	1.42	2.04
2075 High SLR	3.24	3.86

RSLR could impact the benefits achieved by the TSP. Because the project was developed using the intermediate RSLR rate, the TSP would provide fewer benefits than anticipated should the low RSLR rate result and more benefits with the high RSLR rate. With the high rate the

nonstructural component would be less effective because structures would have to be raised to a height that would increase their risk from wind damage during a storm.

Storms: Uncertainty with regard to the size and frequency of storms and meteorological events, such as El Nino and La Nina, cannot be predicted over a set period of time. The storm record is constantly being updated and a large storm such as Hurricane Rita or a slow moving storm such as Isaac can alter the expected return period for other storms. To reduce the uncertainties of storm events, storms with varying degrees of size, intensity, and path were included in the modeling. By using a long-term record of different storm scenarios, the effects of such storms were incorporated into the modeling to reduce the uncertainty in the determination of project benefits. (Engineering Report).

Modeling Factors

ADCIRC and HEC-RAS models appear to provide a specific response on the TSP in any given scenario; however it is only a representative point of reference in a complex system. While the analysis is enhanced by the models, application of the models can introduce error and uncertainty. Calibration and verification efforts are employed so that the models more closely replicate observed changes or at least provide insight into the limitations of the model.

Models are limited by basic, underlying assumptions and uncertainties. Some of the simplifying assumptions include the model parameters. A sensitivity discussion will be completed during feasibility design and included in the engineering report. Another uncertainty is that a limited number of storm scenarios are modeled. It is assumed that various storm scenarios over a number of years will represent a much higher indicator of the ability for nonstructural solutions to appropriately avoid or minimize surge related damages from major storm events.

Models use available historic data to extrapolate future storm conditions and frequency. The size and frequency of storms included are based on statistical analysis but do not account for meteorological changes that can increase or decrease storms over a period of several years. The models do not account for the potential of increased storms due to climate change.

Economic Factors

The economic risk is under or overestimating the future benefits associated with the project alternatives. The with-project damages and overall benefits associated with the alternatives were estimated based on the existing and future without-project damages. For structural plans or features this could potentially result in the plan or feature not being economically justified or preliminary estimates of the benefit cost ratios being overstated. However, no structural features were identified as part of the TSP.

The Hydrologic Engineering Center Flood Damage Analysis (HEC-FDA) Version 1.2.5a certified model was used to calculate the damages for the without project existing and future conditions. Economic and engineering inputs were used to calculate damages for without project existing conditions (2012), the project base year (2025), and the end of the period of analysis (2075).

The uncertainty surrounding each of the economic and engineering variables was entered into the model. A probability distribution was entered into the model to quantify the uncertainty associated with the key economic variables. The number of years that stages were recorded at a given gage was entered for each study area reach to quantify the hydrologic uncertainty or error surrounding the stage-probability relationships.

The nonstructural costs were estimated based on the number of structures within the 100 year floodplain. Relative sea level rise significantly effects the determination of the number of structures to be raised. This means that uncertainty in the projected future RSLR translates directly to uncertainty as to how many structures would have to be raised.

4.1.6 Real Estate Requirements

Costs for the nonstructural features were included as construction costs and not as separable real estate acquisition costs. In the economically justified reaches, a maximum of 3,915 structures are eligible for inclusion in a voluntary program. The plan would include but may not be limited to real property acquisitions, structure raisings, relocations and flood proofing. During feasibility, the availability of benefits under the Uniform Relocation Act will be considered. A detailed evaluation of the work entailed in structure raising and the interests in real property to be obtained will be accomplished during the feasibility design and analysis. The tentative nonstructural project feature implementation plan will be outlined within the Real Estate Plan. The REP and real estate cost estimates will be refined during feasibility design. The NFS will be responsible for acquiring all necessary real estate interests for the project.

4.1.7 Summary of Environmental Consequences of NED Plan.

The alternative NED plan avoids and minimizes to the maximum extent practicable, or would seek to mitigate impacts to significant resources. The initial evaluation indicates that there is low likelihood of impact requiring mitigation. This evaluation will be refined in the feasibility design and additionally in PED. Based upon preliminary information, the NED TSP has identified 3,915 residential and non-residential structures that would be eligible for inclusion in a voluntary program implementing range nonstructural actions; however, the figure will be refined during design.

4.2 National Ecosystem Restoration (NER) Plan

4.2.1 Description of the NER Tentatively Selected Plan (TSP)

The NER TSP (Alternative CM-4) consists of a broad range of ecosystem restoration measures including marsh restoration features (which involves hydraulic dredging of sediments), hydrology and salinity control structures, shoreline protection/stabilization features, oyster reef preservation, and Chenier reforestation. The NER TSP features comprise an integrated comprehensive programmatic plan that will have synergy with other ecosystem restoration projects and facilitate hydrologic and geomorphic stability and resilience. Each restoration measure, with its associated benefits and estimated costs are identified in Table 4-2. A full listing of each features in the NER TSP was presented Table 2-15 in the discussion of the NER final array in Section 2.4.5.

Table 4-2: NER Plan Features.

Restoration Measure	# of Features	Net Benefits	Parishes	Cost
Marsh Restoration	9	8,714 acres	Calcasieu, Cameron, Vermilion	$622,000,000
Hydrology/Salinity Control	2 (one is an existing structure)	6,092 acres	Cameron	$8,300,000
Shoreline Protection/Stabilization	5	5,509 acres (266,884 feet)	Cameron, Vermilion	$360,000,000
Sabine Lake Oyster Reef Preservation	1	TBD	Cameron	$0*

Chenier Reforestation	22	1,413 acres	Cameron, Vermilion	$246,000
Total	**52**	**21,728**	**---**	**~$992,000,000**

* No costs for this feature since it is a nonstructural solution (prevention of harvesting oysters on the reef).

Each of the marsh restoration features involves delivering sediments to open water or eroding marsh areas (minimum of 100 acres) that have water levels of less than two feet and that have been optimized to preserve or restore critical geomorphologic features to create new vegetated wetlands. The marsh restoration locations include: (a) three areas on the south side of Highway 82 approximately 4.5 miles west of Grand Chenier; (b) Pecan Island west of the Freshwater Bayou Canal approximately 5 miles north of the Freshwater Bayou locks; (c) Christian Marsh located east of Freshwater Bayou Canal and approximately 5 miles north of Freshwater Bayou locks; (d) southern shoreline of GIWW west of Calcasieu Ship Channel near Black Lake; (e) eastern rim of Calcasieu Lake within the Cameron-Creole Watershed; (f) east of Mud Lake and north of Highway 82; (g) Mud Lake west of Calcasieu Ship Channel adjacent to southern rim of West Cove. These nine marsh features will / restore approximately 8,600 acres and nourish 4,000 acres, resulting in an estimated net 8,700 acres. Dredged material sources will be the Calcasieu Ship Channel and other nearby sites. All marsh restoration locations will have one future re-nourishment cycle.

The two hydrologic and salinity control features consist of: (1) the existing Cameron-Creole Spillway south of Lambert Bayou, which will serve as a drainage manifold and the outfall channel into Calcasieu Lake, which will be rock-lined for scour protection and built to +4 feet; and (2) the Little Pecan Bayou Stillwater Sill, which will include construction of a rock weir. These features are designed to regulate the flow of water in certain areas, to inhibit salinity intrusion above a certain threshold and increase wetland productivity and create/restore/nourish an estimated 6,100 net acres. Only features in this category that provided benefits of at least 500 net acres are recommended in the TSP.

The five shoreline protection/stabilization features, which span approximately 267,000 linear feet and are anticipated to result in approximately 5,500 net acres, will be used to reduce erosion of canal banks and shorelines in critical areas in order to protect adjacent wetlands and critical geomorphic features. Only features associated with wetland areas capable of producing gains in excess of 100 net acres are recommended as part of the NER TSP.

The existing oyster reef in the lower Sabine Lake will be preserved through the enforcement of perpetual oyster harvesting restrictions to improve water quality and protect nearby shorelines and wetlands.

Chenier restoration consists of replanting of 435 seedlings per acre at 10’ x 10’ spacing, in 22 Chenier locations on 1,400 acres in Cameron and Vermilion parishes. Areas eligible for Chenier restoration consist of areas greater than five feet in elevation and with low shoreline erosion rates, provided the existing canopy coverage is less than 50% unless nearby development would prevent achieving study objectives.

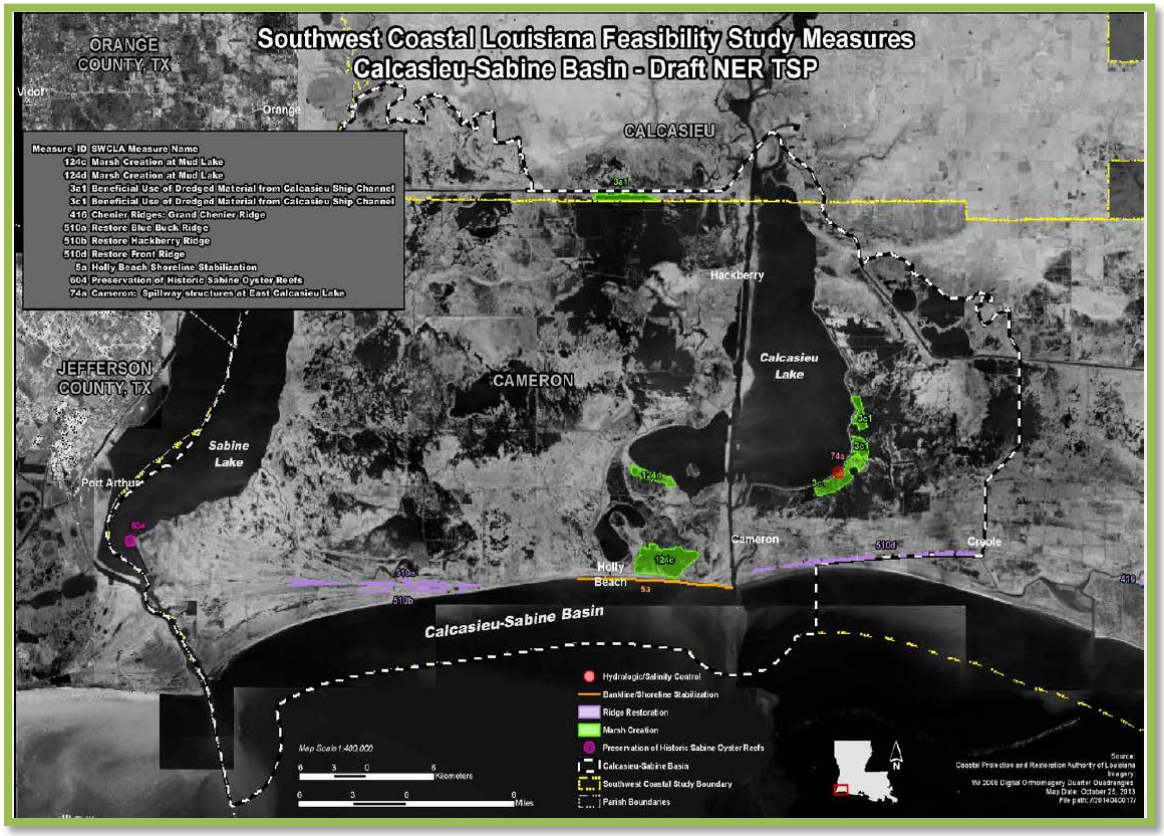


Figure 4-2a: NER TSP features (Calcasieu).

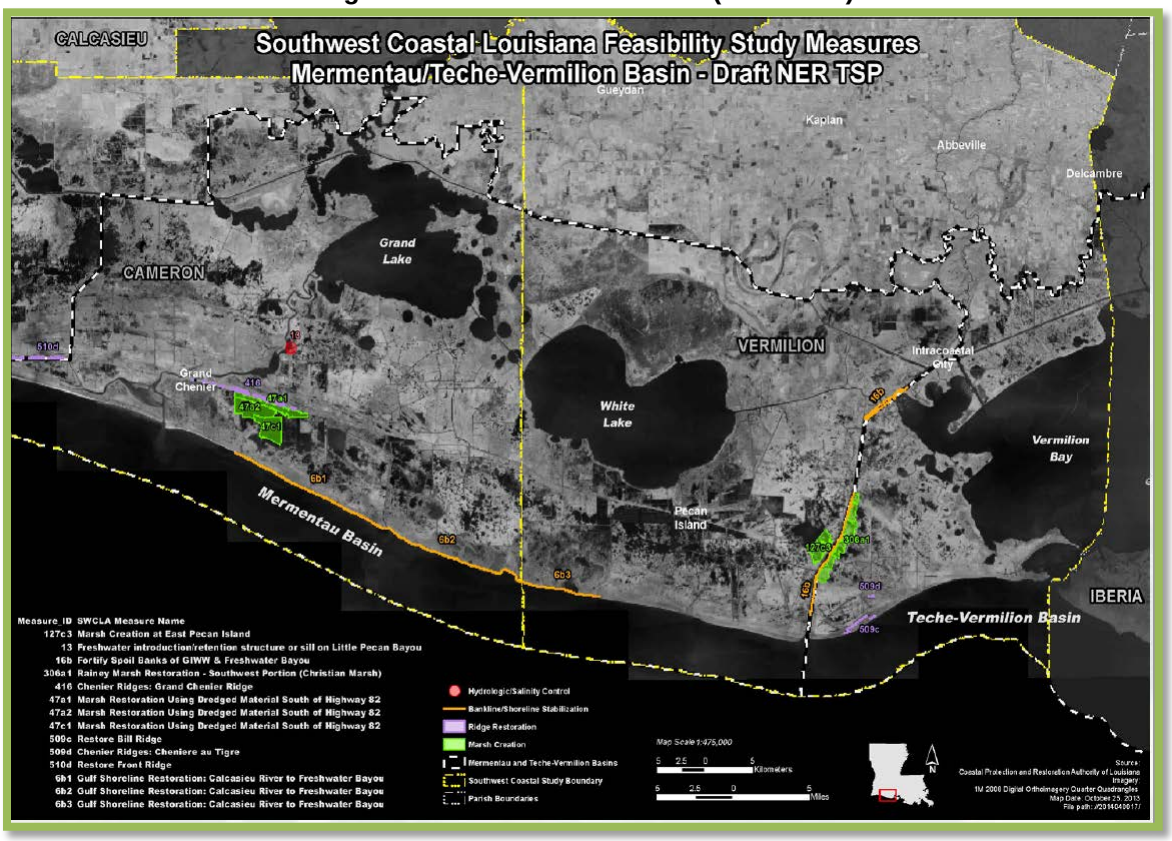


Figure 4-2b: NER TSP Features (Mermentau).

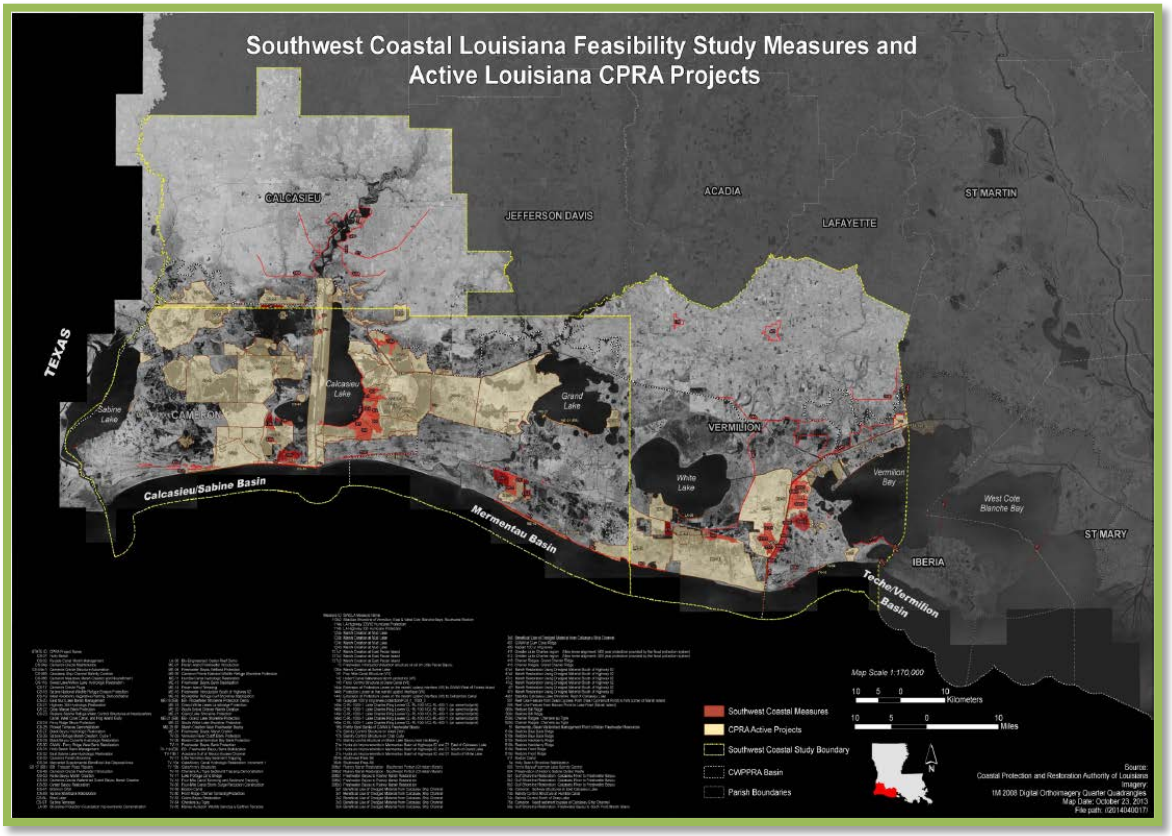


Figure 4-3: Ecosystem restoration activities in the study area.

4.2.2 Adaptive Management and Monitoring

The preliminary metrics/performance measures required to monitor and measure project performance and establish an Adaptive Management and Monitoring (AM&M) program are being developed. Details of the preliminary AM&M actions are set forth in Appendix A, Annex L. The AM&M plan will identify performance measures, desired outcomes/success criteria, potential monitoring designs, data assessment, data management, AM&M responsibilities, estimated costs, and a decision making process. The level of detail in the AM&M plan is based on currently available project data and will be updated further in the feasibility design phase with refinement in preconstruction engineering and design (PED), a detailed AM&M plan, including a detailed cost breakdown, will be drafted in the feasibility design phase. For cost estimating purposes, 3% of the total project costs have been used as an estimate of the AM&M costs for the NER.

4.2.3 NER Plan Operation, Maintenance, Repair, Rehabilitation and Replacement OMRR&R.

OMRR&R for the NER Plan features consists of marsh renourishment, through the periodic addition of dredged sediment, to maintain wetland elevations, future lifts and additions of material for rock and/or rip-rap features, and maintenance, repair and replacement of the hydrologic/salinity control features. The estimated annual OMRR&R cost for the NER features is $5,382,000, which will be refined during feasibility design. The NFS shall commence OMRR&R once USACE issues a notice of construction completion together with the OMRR&R Manual to the NFS. OMRR&R measures attributable to the preservation of the Sabine Lake Oyster Reef will be determined prior to final feasibility.

4.2.4 Risk and Uncertainty Analysis

Risk and uncertainty are intrinsic factors in water resource plans. This section describes risk and uncertainty categories pertinent to the study. These will be considered in feasibility.
Environmental Factors

Relative Sea Level Rise: An assessment of RSLR was included in plan formulation and alternatives analysis, however there is uncertainty about how much sea level change may occur. Higher than estimated RSLR could cause salt water intrusion further into the estuary, causing significant changes to lower salinity wetlands. An assessment of RSLR was included in plan formulation and alternatives analysis. Values for the RSLR rates were previously presented in Table 4-1. A graphic of the projected rates is presented below in Figure 4-4.

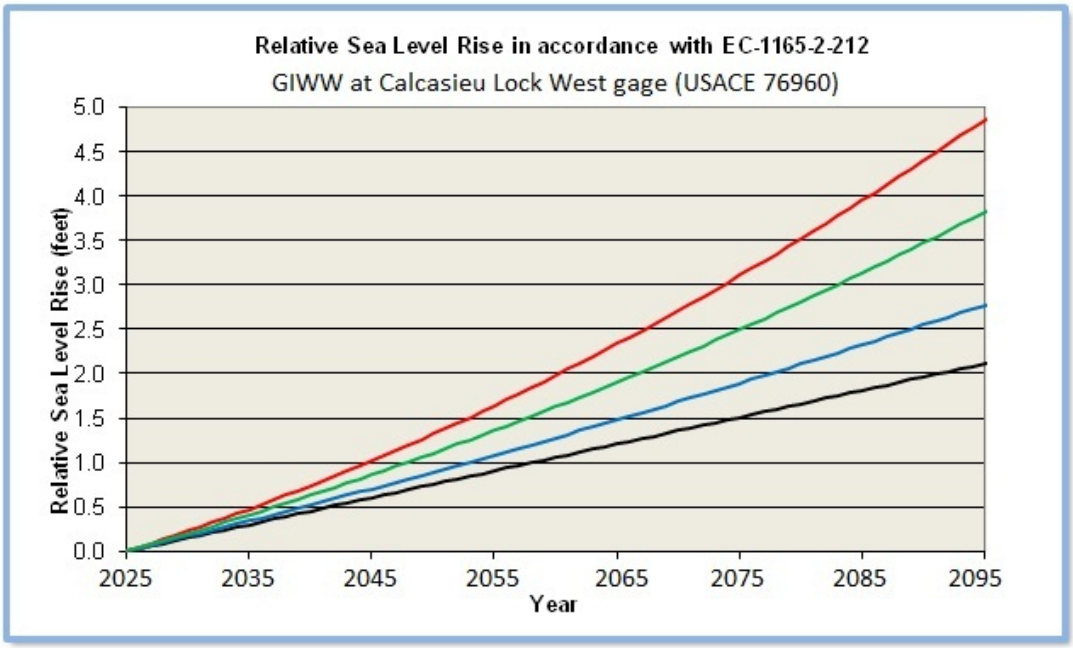


Figure 4-4: Sea-Level and Relative Sea-Level Rates for the Study Area.

RSLR could impact the benefits of the TSP. Because the features were developed using the intermediate RSLR rate, the TSP would provide more benefits than anticipated if the lower RSLR rate occurs and less benefits if the higher RSLR rate occurs. With the high rate the marsh restoration and shoreline protection/stabilization features would be less effective because they could be overwhelmed by water levels. This could increase their vulnerability.

Storms: Risks associated with the TSP relate to possible extreme weather events. Uncertainty about the size or frequency of storms and climate events, such as El Nino, cannot be predicted over a set period of time. Storm events can cause significant damage to wetlands. Intact habitats are more resilient against the effects of storm surge and associated flooding, salinity spikes, and tidal scour, though some storm damages may be unavoidable.

4.2.5 Real Estate Requirements

A Real Estate Plan (REP) describes the project real estate requirements and costs. Identification of all of the real property interests and estates required for implementation of the NER TSP will be considered during preconstruction engineering and design. Locations of the final array of alternatives were used to prepare preliminary cost estimates, but information on right-of-way required for access, borrow, staging, mitigation, Uniform Relocation Act, etc. was not available. The REP and estate cost estimates will be refined during feasibility design.

The NER Plan requires an estimated 25,619 acres of real estate acquisition from 260 landowners. For feasibility design, maps will be prepared to show required project rights-of-way, including access, borrow, staging and other project features.

The majority of the NER features are on privately owned land and will require the acquisition of a standard Fee, Excluding Minerals (with restriction of use of surface) estate. A Request to Deviate from Fee Acquisition and Request for Approval of a Non-Standard Estate will be prepared and submitted as an independent document for this project. For the purposes of this report, it is stated that fee simple title will be acquired for the NER project features. Project features on federal lands will require a Special Use Permit from the U.S. Fish and Wildlife Service.

More detailed information regarding real estate acquisition for the NER plan is found in the REP.

4.2.6 Summary of Environmental Consequences of NER Plan.

Restoration and protection/stabilization features for the NER plan are designed to be self-mitigating and will not require compensation. Table 4-2 depicts the NER benefits for all TSP features.

4.2.7 Significance of Benefits for the NER Plan

Significance of the NER benefits is reflected in Table 4-2. A total of 21,728 net acres will be restored, and/or protected as a result of the various features of the NER Plan. The acres benefited are attributable to NER measures for marsh restoration, shoreline protection/stabilization, Chenier reforestation, hydro/salinity control, and oyster reef preservation, as compared to these net acres not being restored under the No Action Alternative. In addition, the proposed action would be synergistic with existing, authorized restoration projects identified in Figure 4-3.

All of the action plans would protect and restore significant resources. The institutional significance of these resources is demonstrated by the Clean Water Act of 1972; Coastal Barrier Resources Act of 1982; Coastal Zone Management Act of 1972; Emergency Wetlands Resources Act of 1986; Estuary Protection Act of 1968; Fish and Wildlife Conservation Acts of 1980 and 1958; Migratory Bird Conservation Act; Migratory Bird Treaty Act; Endangered Species Act of 1973; Magnuson-Stevens Fishery Conservation and Management Act of 1976, as amended; Bald and Golden Eagle Protection Act of 1940; NEPA of 1969; the North American Wetlands Conservation Act; the Water Resources Development Acts of 1976, 1986, 1990, 1992, and 2007; the Rivers and Harbors Act of 1899; the Watershed Protection and Storm Damage Protection Act of 1954; EO 11990 Protection of Wetlands; EO 12898 Environmental Justice; and EO 13186 Migratory Bird Habitat Protection.

The resources of the area are also technically significant because of the uniqueness of the ecosystem, scarcity of the habitats that comprise the system, species richness and biodiversity produced by the system, and the area‘s importance to species of concern. Louisiana is losing land at an alarming rate between 20 and 50 square miles a year (USGS 1995, USGS 2011). Approximately 1,900 square miles of coastal habitat was lost between 1932 and 2010 (USGS 2011). The vegetative communities that would be restored by the NER plan provide protection against substrate erosion and contribute food and structure for cover, nesting, and nursery habitat for wildlife and fish. Continued degradation and loss of existing areas, along with truncation of replenishing processes, will accelerate decline in the interdependent processes of plant production and vertical maintenance necessary for a stable ecosystem.

Coastal habitats are publicly significant because of the high priority that the public places on their aesthetic, ecological, recreational, and cultural value. The involvement of national, state, and local organizations in restoration efforts demonstrates the public significance of these resources. The National Audubon Society, the Nature Conservancy, National Wildlife Federation and Ducks Unlimited are examples of national organizations actively involved in area restoration. The entire ecosystem has global, national, state, and local significance, and every part contributes to the unique services and functions of the whole.

4.3 Implementation Requirements

The NFS and USACE will design features. Preconstruction engineering and design, and construction will follow USACE regulations and standards. Lands, easements, right-of-ways, relocations and borrow/disposal areas (LERRDs) are an NFS obligation. (Real Estate Plan). A preliminary description of the non-Federal sponsor obligations is set forth below; however, with regard to the NED TSP, the items of non-Federal sponsor obligation may be refined prior to the final feasibility report.

4.4 Cost Sharing and Non-Federal Sponsor Responsibilities

The State of Louisiana, acting through the CPRAB, is the study NFS. The CPRAB is anticipated to be the non-Federal Sponsor for the planning, design, construction, operation, maintenance, repair, rehabilitation, and replacement of the project. The cost share for the planning, design and construction is 65% Federal and 35% non-Federal. The NFS must provide all project LERRDs. OMRR&R is a 100% NFS responsibility. Federal implementation of the project would be subject to the non-Federal sponsor agreeing to comply with applicable Federal laws and policies, including but not limited to:

4.4.1 Items of Local Cooperation common to SWC project for the NER and NED TSP:

a. Provide 35 percent of total project costs as further specified below:

1. Provide the non-Federal share of design costs allocated by the Government in accordance with the terms of a design agreement entered into prior to commencement of design work for the project;

2. Provide, during the first year of construction, any additional funds necessary to pay the full non-Federal share of design costs;

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

4. Provide, during construction, any additional funds necessary to make its total contribution equal to 35 percent of total project costs;

b. Not use funds provided by a Federal agency under any other Federal program, to satisfy, in whole or in part, the non-Federal share of the cost of the project unless the Federal agency that provides the funds determines that the funds are authorized to be used to carry out the project;

c. Comply with all applicable provisions of the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970, Public Law 91-646, as amended (42 U.S.C. 4601-4655), and

the Uniform Regulations contained in 49 CFR Part 24, in acquiring lands, easements, and rights-of-way required for construction, operation, and maintenance of the project, including those necessary for relocations, the borrowing of materials, or the disposal of dredged or excavated material; and inform all affected persons of applicable benefits, policies, and procedures in connection with said Act;

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

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

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

g. Keep and maintain books, records, documents, or other evidence pertaining to costs and expenses incurred pursuant to the project, for a minimum of 3 years after completion of the accounting for which such books, records, documents, or other evidence are required, to the extent and in such detail as will properly reflect total project costs, and in accordance with the standards for financial management systems set forth in the Uniform Administrative Requirements for Grants and Cooperative Agreements to State and Local Governments at 32 Code of Federal Regulations (CFR) Section 33.20;

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

i. Comply with all applicable Federal and State laws and regulations, including, but not limited to: Section 601 of the Civil Rights Act of 1964, Public Law 88-352 (42 U.S.C. 2000d) and Department of Defense Directive 5500.11 issued pursuant thereto; Army Regulation 600-7, entitled "Nondiscrimination on the Basis of Handicap in Programs and Activities Assisted or Conducted by the Department of the Army” and all applicable Federal labor standards requirements including, but not limited to, 40 U.S.C. 3141- 3148 and 40 U.S.C. 3701 – 3708 (revising, codifying and enacting without substantial change the provisions of the Davis-Bacon Act (formerly 40 U.S.C. 276a et seq.), the Contract Work Hours and Safety Standards Act (formerly 40 U.S.C. 327 et seq.), and the Copeland Anti-Kickback Act (formerly 40 U.S.C. 276c et seq.);

j. Perform, or ensure performance of, any investigations for hazardous substances that are determined necessary to identify the existence and extent of any hazardous substances regulated under the Comprehensive Environmental Response, Compensation, and Liability Act

(CERCLA), Public Law 96-510, as amended (42 U.S.C. 9601-9675), that may exist in, on, or under lands, easements, or rights-of-way that the Federal Government determines to be required for construction, operation, and maintenance of the project. However, for lands that the Federal Government determines to be subject to the navigation servitude, only the Federal Government shall perform such investigations unless the Federal Government provides the non-Federal sponsor with prior specific written direction, in which case the non-Federal sponsor shall perform such investigations in accordance with such written direction;

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

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

4.4.2 Items of local cooperation unique to NER portion of the SWC project:

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

b. Provide the non-Federal share of that portion of the costs of mitigation and data recovery activities associated with historic preservation, that are in excess of 1 percent of the total amount authorized to be appropriated for the project;

c. Not use project or lands, easements, and rights-of-way required for the project as a wetlands bank or mitigation credit for any other project.

4.4.3 Items of local cooperation unique to NED portion of the SWC project:

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

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

c. Agree to participate in and comply with applicable Federal floodplain management and flood insurance programs;

d. Comply with Section 402 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 701b-12), which requires a non-Federal sponsor to prepare a floodplain management

plan within one year after the date of signing a project partnership agreement, and to implement such plan not later than one year after completion of construction of the project;

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

f. Shall not use any project features or lands, easements, and rights-of-way required for such features as a wetlands bank or mitigation credit for any other project;

g. Pay all costs due to any project betterments or any additional work requested by the sponsor, subject to the sponsor's identification and request that the Government accomplish such betterments or additional work, and acknowledgement that if the Government in its sole discretion elects to accomplish the requires to so notify the non-Federal sponsor in writing that sets forth any applicable terms and conditions.

4.4.4 Cost Apportionment

The OMRR&R costs for the NER TSP have an estimated present value of $4,128,075 at 2012 price levels (see Table 4-3).

Table 4-3: Cost apportionment of the TSP (NED and NER).

	NED	NER	Total	Federal	Non-Federal
PED*	$31,000,000	$75,524,000	$106,524,000	$69,241,000	$37,283,000
Construction	$388,000,000	$991,743,000	$1,379,743,000	$896,833,000	$482,910,000
Lands, Easements, & ROW	$---	$21,609,000	$21,609,000	**$	$21,609,000
Monitoring and Adaptive Management***	$---	$39,510,000	$39,510,000	$25,682,000	$13,829,000
Total First Costs#	$419,000,000	$1,128,386,000	$1,547,386,000	$991,756,000	$555,631,000

* Costs include contingencies
** Federal costs are the Administrative Cost of NFS Oversight
*** Monitoring and Adaptive Management estimated at 3% of total NER costs.
# This will result in a total project cost split of 65% Fed/35% Non-Fed which accounts for non-Fed responsibilities

5.0 ENVIRONMENTAL LAWS AND COMPLIANCE (*NEPA REQUIRED)

Federal projects must comply with Federal and state environmental laws, regulations, policies, rules and guidance. The USACE will continue to coordinate with Federal and state resource agencies through release of the Final Programmatic Environmental Impact Statement (PEIS). Compliance with the various laws and executive orders (EO) is presented below and discussed in more detail in appendix A.

Table 5-1: Status of environmental compliance.

Law, Regulation, or Policy	Status	Comments	Full Compliance Expected
Anadromous Fish Conservation Act of 1965	Coordination ongoing	Anadromous fish species would not be affected by the proposed action. Coordination with NMFS is ongoing.	Compliance achieved following coordination, disclosure and NMFS review of Final PEIS.
Bald and Golden Eagle Protection Action of 1940	Coordination ongoing	Based on review of existing data and preliminary field surveys, the CEMVN finds the TSP would have no effect on bald or golden eagles, or their critical habitat. Subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance following coordination, disclosure and USFWS review of Final PEIS.
Clean Air Act of 1970	Coordination ongoing	Sec. 309: EPA will rate the document during the public comment period. Sec. 176: Project area currently in attainment of NAAQS. No general conformity determination required	Compliance after disclosure and EPA, LDEQ review of Final PEIS.
Clean Water Act of 1977	Coordination ongoing	Section 401: water quality certification from LDEQ is not required for PEIS. Section 404: A 404(b)(1) Evaluation is not required for a PEIS. Both would be conducted prior to implementation and upon completion of further NEPA analysis.	Section 401 Certification not applicable at programmatic level. Sec 404 compliance not applicable at programmatic level.
Coastal Zone Management Act of 1972	Coordination ongoing	A programmatic consistency determination will be prepared prior to FPEIS, submitted to LDNR for consistency review with the Louisiana Coastal Resource Program.	Compliance with receipt of programmatic coastal zone consistency determination from LDNR, disclosure and review of Final PEIS.
Coastal Barrier Resources Act of 1982 and Coastal Barrier Improvement Act of 1990	Coordination ongoing	The TSP would have temporary adverse effect but would provide long term permanent benefits to coastal barrier shoreline resources. However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance achieved upon disclosure and review of Final PEIS.
Endangered Species Act of 1973	Coordination ongoing	A Programmatic Biological Assessment (BA) will be prepared and consultation with NMFS/USFWS concluded prior to FPEIS. However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance after NMFS and USFWS review the final programmatic BA, conclusion of T&E consultation, disclosure and review of Final PEIS.
Estuary Protection Act of 1968	Coordination ongoing	It is anticipated that estuaries would be benefited by this project. However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance achieved following disclosure and review of Final PEIS.
Farmland Protection Policy Act of 1981	Coordination ongoing	Impacts to prime and unique farmlands from the TSP will be coordinated with the NRCS. However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance achieved through coordination with NRCS, disclosure and review of Final PEIS.
Federal Water Project Recreation Act of 1965	Coordination ongoing	Recreational opportunities will be investigated in subsequent NEPA documents prior to implementing TSP.	Compliance achieved upon disclosure and review of Final PEIS.

Law, Regulation, or Policy	Status	Comments	Full Compliance Expected
Fish and Wildlife Coordination Act of 1958	Coordination ongoing	USFWS provided a draft Fish and Wildlife Coordination Act Report (CAR) dated Nov 5, 2013 and supplemental letter dated Dec 3, 2013.	Compliance achieved following receipt of final FWCAR and USFWS review of Final PEIS.
Magnuson-Stevens Fishery Conservation and Management Act of 1976	Coordination ongoing	A full EFH assessment would be conducted in subsequent NEPA documents implementing the TSP.	Compliance achieved following disclosure of EFH programmatic consultation and review of Final PEIS.
Marine Mammal Protection Act of 1972	Coordination ongoing	With implementation of BMP the West Indian Manatee and dolphin is not likely to be adversely affected. However, subsequent NEPA would be completed prior to implementing the TSP.	Compliance achieved upon conclusion of consultation with the USFWS/NMFS. Disclosure and review of Final PEIS.
Marine Protection, Research, and Sanctuaries Act of 1972	Coordination ongoing	No adverse impacts are anticipated however subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance upon disclosure and review of Final PEIS.
Migratory Bird Treaty Act of 1918 and Migratory Bird Conservation Act of 1929	Coordination ongoing	Based on review of existing data and preliminary field surveys, the CEMVN finds the TSP would have no adverse effect on colonial nesting water birds or other migratory species; However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance after USFWS review of the Final PEIS.
National Environmental Policy Act of 1969	Coordination ongoing	Draft PEIS is being coordinated with the public/agencies for a 45 day comment period. However, subsequent NEPA analysis would be completed prior to implementation.	Compliance upon coordination of the Final PEIS, remaining public involvement activities completed, and signing ROD.
National Historic Preservation Act of 1966	Coordination ongoing	Consultation with SHPO and Federally-recognized Tribes is ongoing. A programmatic agreement will be negotiated prior to release of FPEIS.	Programmatic compliance following conclusion of Section 106 consultation, disclosure and review of Final PEIS.
Submerged Lands Act of 1953	Coordination ongoing	Coordination with LDNR and LDWF is ongoing.	Compliance achieved upon disclosure and LDNR, LDWF review of Final PEIS.
Rivers and Harbors Act of 1899	Analysis On-going	The proposed Hydro and salinity control structures may impact navigation. The existing structure at Measure 74a currently impedes navigation. It is anticipated measure 13 would not impede navigation. However, subsequent NEPA analysis would be completed prior to implementing TSP.	Compliance achieved upon disclosure and review of Final PEIS.
Resource Conservation and Recovery Act of 1976; Comprehensive Environmental Response, Compensation, and Liability Act of 1980; Toxic Substances Control Act of 1976	Analysis On-going	A standard Phase I Environmental Site Assessment is not necessary at the programmatic level. This would be conducted in a subsequent NEPA document completed prior to implementing TSP.	Compliance achieved upon disclosure and review of PFEIS.
Wild and Scenic River Act of 1968	Coordination ongoing	The northern reach of the Calcasieu River that is designated as a Wild and Scenic river is in northeastern Calcasieu Parish and will not be affected by the TSP.	Compliance achieved upon disclosure and review of Final PEIS.
E.O. 11514 Protection and Enhancement of Environmental Quality,1970	Complete	The TSP complies with this EO.	Compliant.
E.O. 11988 Floodplain Management, 1977	Coordination ongoing	Portions of the proposed TSP would be located in the 100-year floodplain. However, subsequent NEPA analysis would be completed prior to implementing TSP.	Compliance achieved after Calcasieu, Cameron, Vermilion Parish Floodplain Administrators review the Final PEIS.

Law, Regulation, or Policy	Status	Comments	Full Compliance Expected
E.O. 11990 Protection of Wetlands, 1977	Coordination ongoing	Measures to avoid, minimize, and reduce impacts to wetlands will be maximized to the extent possible. No compensatory mitigation for unavoidable impacts is anticipated currently. However, subsequent NEPA analysis would be completed prior to implementing the TSP.	Compliance following programmatic design of the TSP; disclosure and review of Final PEIS.
E.O. 12898 Environmental Justice for Low Income and Minority Populations, 1994	Coordination ongoing	Due to programmatic nature of the TSP further evaluation is required to fully determine whether minority or low-income communities would be disproportionally affected. However, subsequent NEPA analysis and public comment would be completed prior to implementing the TSP.	Compliance achieved upon disclosure and review of Final PEIS.
E.O. 13112 Invasive Species, 1999	Coordination ongoing	The project is not expected to lead to propagation of invasive species. This would be evaluated further in subsequent NEPA documents prior to implementing the TSP.	Compliance achieved upon disclosure and review of Final PEIS.
E.O. 13175 Consultation and Coordination with Tribal Governments, 2000	Coordination ongoing	Coordination with Tribes is ongoing. Coordination would continue through preparation of subsequent NEPA documents prior to implementing the TSP.	Compliance achieved upon conclusion of Tribal consultation, disclosure, and review of Final PEIS.
E.O. 13186 Responsibilities of Federal Agencies to Protect Migratory Birds, 2001	Coordination ongoing	No compensatory mitigation for unavoidable project-induced impacts to bird and wildlife habitat is anticipated. This would be evaluated further in subsequent NEPA documents implementing the TSP.	Compliance achieved upon disclosure and review of Final PEIS.

5.1 Fish and Wildlife Coordination

The Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.) provides authority for the USFWS involvement in evaluating impacts to fish and wildlife from proposed water resource development projects. It requires Federal agencies that construct, license or permit water resource development projects to first consult with the U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS) and state resource agencies regarding the impacts on fish and wildlife resources and measures to mitigate impacts. In accordance with Section 2(b) of the FWCA, the USFWS provided a Draft Coordination Act Report (CAR) dated November 5, 2013. A supplemental letter to the Draft CAR dated December 3, 2013 revokes recommendations 1 through 5 that reference the proposed storm surge protection levees. The USFWS recommendations are listed below minus recommendations 1 through 5. CEMVN has not responded to USFWS recommendations at this time.

To complete needed planning of project features, to reduce and avoid project-related adverse impacts to fish and wildlife resources, and to enhance the desired ecosystem benefits, the USFWS provides the following recommendations:

6. For ecosystem restoration measures not being used to mitigate construction impacts, the Service recommends that the Corps conduct monitoring of those features to document the degree of success achieved. The Service and other interested natural resource agencies should be involved in developing those monitoring criteria and in the review of subsequent monitoring information and reports. For mitigation features, the Service also recommends that all interested natural resource agencies be involved in the planning of project features,

monitoring plans, development of success criteria, and adaptive management plans. In addition, all mitigation plans should address the 12 mitigation requirements in Appendix A.

7. The Corps should obtain a right-of-way from the Service prior to conducting any work on Sabine or Cameron Prairie National Wildlife Refuges, in conformance with Section 29.21-1, Title 50, Right-of-Way Regulations. Issuance of a right-of-way will be contingent on a determination that the proposed work will be compatible with the purposes for which the Refuge was established.

8. All construction or maintenance activities (e.g., surveys, land clearing, etc.) on National Wildlife Refuges (NWRs) will require the Corps to obtain a Special Use Permit from the Refuge Manager of the Southwest Louisiana Refuge Complex; furthermore, all activities on NWRs must be coordinated with the Refuge Manager. Therefore, we recommend that the Corps request issuance of a Special Use Permit well in advance of conducting any work on the refuge. Please contact the Refuge Manager (337/598-2216 or SWLRComplex@fws.gov) for further information on compatibility of proposed ecosystem restoration measures, and for assistance in obtaining a Special Use Permit. Close coordination by both the Corps and its contractor must be maintained with the Refuge Manager to ensure that construction and maintenance activities are carried out in accordance with provisions of any Special Use Permit issued by the NWR.

9. The Corps should contact the Louisiana Department of Wildlife and Fisheries prior to conducting any work on Rockefeller Refuge (337-491-2593).

10. The Corps should continue to coordinate with the Service throughout planning and construction to ensure that the proposed project does not impact waterbird nesting colonies, and threatened or endangered species that may be listed in the future.

Given that the design and evaluation of most project features has been at a programmatic level, the Service cannot fulfill its FWCA responsibilities at this time. Therefore, this draft report is presented in partial fulfillment of that act and does not constitute the final report of the Secretary of Interior as required by Section 2(b) of the FWCA. To complete those assessments, we will require additional funding during the project's pre-construction engineering and design phase. Estimates of those funding needs should be coordinated in advance with the Service, and should be based on the extent of remaining work and the nature and complexity of issues associated with the remaining planning/design issues.

6.0 PUBLIC INVOLVEMENT (*NEPA REQUIRED)

Engaging and listening to the public is an important part of the USACE Campaign Plan as illustrated in the objective "Enhance trust and understanding with customers, stakeholders, teammates, and the public through strategic engagement and communication." The study team has pursued public involvement as a key planning strategy.

Government agencies, non-governmental organizations, and citizens provide valuable input into the development of a tentatively selected plan. Efforts began with the study scoping process and will continue through a formal comment period and further opportunities to review study details and offer input into the planning. In addition to traditional mailings, a web site and other social media tools were used in an effort to broadly distribute study information.

The National Environmental Policy Act (NEPA) gives people, organizations, and governments time to review and comment on proposed major Federal actions. This occurs throughout planning beginning with scoping meetings and continuing through comment periods on draft and final reports. Comments are accepted and considered throughout the planning process.

6.1 Public Scoping Meetings

Scoping is the initial step to prepare an environmental impact statement (EIS). It helps identify: (1) the range of actions (project and procedural changes), (2) alternatives (both those to be explored rigorously and evaluated, and those that may be eliminated), and (3) the range of environmental resources considered in impact evaluations. A scoping report (available upon request) includes information about public meetings, meeting notices, and comments. Citizens, agencies, non-governmental organizations, and elected officials attended meetings.

Public Notification: The public was notified of three public scoping meetings (table 6-1) using the following communication mechanisms: (1) A Notice of Intent to prepare a Draft EIS was published in the Federal Register (Volume 74, Number 38) on February 27, 2009. (2) A scoping meeting announcement requesting comments was mailed to Federal, state, and local agencies, and interested groups and individuals on March 13, 2009. (3) A media advisory announcing the scoping meetings was provided to more than 200 media outlets.

Table 6-1: Public scoping meetings.

Date	Parish	Location	Attendees
March 24, 2009 6:00 – 9:00 p.m.	**Cameron Parish** Cameron Parish Courthouse	119 Smith Circle Cameron, LA	51
March 25, 2009 6:00 – 9:00 p.m.	**Calcasieu Parish** Central School Arts & Humanities Center	809 Kirby Street Lake Charles, LA	59
March 26, 2009 6:00 – 9:00 p.m.	**Vermilion Parish** Abbeville High School	1305 Wildcat Dr. Abbeville, LA	170

Scoping Comment Categorization by Theme: The 382 specific comments received were categorized by concern or issue identified by the attendees. A concern or issue raised more than three times became a theme. A total of 13 themes were identified (including "other").

Table 6-2: Scoping comment themes.

Rank	Theme	# of Comments	% Occurrence
1	Storm risk reduction	57	14.9%
2	Importance of considering entire scope of study and cumulative effects of other projects	53	13.9%
3	Coastal protection	52	13.6%

4	Impact of changes to drainage patterns	38	9.9%
5	Importance of cooperation between Federal agencies, parishes, and stakeholders	34	8.9%
6	Timeframe and funding related to project implementation	27	7.1%
8	Salinity and saltwater intrusion	23	6.0%
9	Wetlands protection/restoration	22	5.8%
10	Protection of existing developed land	18	4.7%
11	Permitting issues	15	3.9%
12	Concern regarding loss of Highway 82	12	3.1%
13	Impacts to wildlife	4	1.0%
7	Other*	27	7.1%
	Total	**382**	**100.0%**

* Comments categorized as "other" occurred only once or were not directly related to the proposed action.

6.2 NEPA Cooperating Agencies

Cooperating agencies (as defined under 40 CFR 1501.6) for this study include the following:

- U.S. Department of the Interior–USFWS
- U.S. Department of Commerce–NOAA and NMFS
- U.S. Department of Agriculture–NRCS

6.3 Other agencies participating in the spirit of a "cooperating agency"

Louisiana's Departments of Environmental Quality and Natural Resources also participated but not as formal cooperating agencies.

6.4 Other Public Coordination Efforts

Public meetings were held in the three parish area during the study. These meetings included:

- 2009 - July 21 thru July 23 - Various stakeholder meetings and presentations.
- 2010 - February 22 thru March 4 - Various stakeholder meetings and presentations.
- 2010 - July 12 thru July 15 - Various stakeholder meetings and presentations.
- 2011 - October 3 thru October 6 - Various stakeholder meetings and presentations.
- 2012 - April 3 thru April 6 - Various stakeholder meetings and presentations.
- 2013 - July 31 thru August 2 - Various stakeholder meetings and presentations.

Meeting participants were generally most interested in potential levee alignments and impacts to their communities. Other comments focused on the construction schedule, potential impacts to wetlands, the value of hurricane evacuation routes, and funding.

6.5 Draft Report Recipients

Federal, state, and local government agencies; elected officials; citizens; businesses; libraries, and universities received copies of the report. Notices of availability were mailed to the CEMVN District stakeholder/NEPA mailing lists. A full list of report recipients is available upon request. The following stakeholders received a copy of this report:

Table 6-3: List of report recipients.

Louisiana Congressional Delegation	Louisiana State Senators & Representatives	Levee Districts & Floodplain Management Agencies
Senator Mary Landrieu	Senator Dan "Blade" Morrish	Chenier Plain Restoration & Protection Authority
Senator David Vitter	Senator Jonathan Perry	Iberia Parish Levee District
Congressman Rodney Alexander	Representative Bob Hensgens	
Congressman Charles W.	Representative Simone Champagne	
Congressman William Cassidy		
Congressman John Fleming		
Congressman Cedric Richmond		

Congressman Steve Scalise		
Cameron Parish Government	**Calcasieu Parish Government**	**Vermilion Parish Government**
Darryl Farque, **Police Jury President**	Police Jury	Nathan Granger, Police Jury President
Police Jury	Parish Administrator	Police Jury
Tina Horn, Parish Administrator		Tim Creswell, Assistant Emergency Manager
City of Abbeville Government	**City of Lake Charles Government**	**Town of Delcambre Government**
Mayor	Randy Roach, Mayor	Mayor
Council	City Administrator and City Council	Alderman
Federal Agencies		
Advisory Council on Historic Preservation	**Department of Energy:** Office of Environmental Compliance	**Department of Transportation:** Division Administrator, Federal Highway Administration; Southwest Region, Federal Aviation Administration
Department of Agriculture*:* Carl J. Breville. *Natural Resources Conservation Service:* Kevin Norton, State Conservationist; Michael Trusclair, District Conservationist	**Department of Homeland Security:** *Federal Emergency Management Agency:* Gary Zimmerer, Region VI	**Environmental Protection Agency:** Office of Federal Activities, EIS Filing Section: Region VI, Marine and Wetlands Section; Rhonda Smith, Region VI - Office of Planning and Coordination
Department of the Army: Rayford E. Wilbanks	**Department of the Interior:** *Office of Environmental Policy and Compliance. U.S. Fish and Wildlife Service:* Lacombe Office ; Lafayette Field Office, Jeff Weller, Field Supervisor	**Department of Commerce:** *National Oceanic and Atmospheric Administration:* David Bernhart, Protected Species Division; Richard Hartman, Habitat Conservation Division; NEPA Coordinator, Office of Program, Planning & Integration
Federal Emergency Management Agency: Gary Zimmerer, Region VI		
State of Louisiana Agencies and Offices		
Governor: Honorable Bobby Jindal **Lieutenant Governor:** Jay Dardenne	**Department of Agriculture & Forestry:** Office of Forestry; Mike Strain; Matthew Keppinger, Office of Agriculture & Environmental Science	**Department of Public Works**
Governor's Office for Coastal Activities	**Department of Environmental Quality:** Environmental Planning Division ; Office of the Secretary; Scott Guilliams	**Department of Transportation & Development**
Coastal Protection and Restoration Authority: Gerome Zeringue, Norwyn Johnson	**Department of Health & Hospitals:** Office of Public Health, Center for Environmental Health	**Department of Wildlife & Fisheries:** Secretary; Maurice Watson; Tim Morrison; Gary Lester, Natural Heritage Program
Lake Charles Harbor and Terminal District: Channing Hayden	**Department of Natural Resources:** Keith Lovell, Interagency Affairs; Charlie Mestayer, Lafayette Field Office; Division of State Lands; Office of Conservation, Surface Mining Division; Consistency Coordinator, Coastal Resources Program	**Division of Administration:** State Land Office; State Planning Office
Secretary of State	**Coastal Protection and Restoration Authority Board:** Garret Graves	**Office of Cultural Development:** Pam Breaux, State Historic Preservation Officer; Division of Outdoor Recreation
Office of the Attorney General	**Governor's Office of Indian Affairs**	**State Board of Commerce & Industry**
Federally Recognized Tribes		
Alabama Coushatta Tribe of Texas	Coushatta Tribe of Louisiana	Seminole Nation of Oklahoma
Caddo Nation of Oklahoma	Jena Band of Choctaw Indians	Seminole Tribe of Florida
Chitimacha Tribe of Louisiana	Mississippi Band of Choctaw Indians	Tunica-Biloxi Tribe of Louisiana
Choctaw Nation of Oklahoma	Quapaw Tribe of Oklahoma	

6.6 Views of the Public

This report is available for public review and comment for 45 days. The final report will include comments received. Comments received at public meetings will also be included.