FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR
SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
SOUTHEAST TEXAS AND SOUTHWEST LOUISIANA

VOLUME II

COOPERATING AGENCIES:

U.S. ENVIRONMENTAL PROTECTION AGENCY
U.S. DEPARTMENT OF THE INTERIOR – FISH AND WILDLIFE SERVICE
U.S. DEPARTMENT OF COMMERCE – NATIONAL MARINE FISHERIES SERVICE
TEXAS GENERAL LAND OFFICE
LOUISIANA DEPARTMENT OF WILDLIFE AND FISHERIES

PREPARED BY:

U.S. ARMY CORPS OF ENGINEERS
GALVESTON DISTRICT
SOUTHWESTERN DIVISION

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ABSTRACT

FINAL ENVIRONMENTAL IMPACT STATEMENT
PROPOSED SABINE-NECHES WATERWAY
CHANNEL IMPROVEMENT PROJECT
SOUTHEAST TEXAS AND SOUTHWEST LOUISIANA

The responsible agency for this action is the U.S. Army Corps of Engineers, Galveston District (USACE). The non-Federal sponsor is the Sabine Neches Navigation District (SNND). The U.S. Environmental Protection Agency, U.S. Department of the Interior – Fish and Wildlife Service, U.S. Department of Commerce – National Marine Fisheries Service, Texas General Land Office, and the Louisiana Department of Wildlife and Fisheries are cooperating agencies.

Abstract: This Final Environmental Impact Statement (FEIS) was prepared as required by the National Environmental Policy Act (NEPA) to present an evaluation of potential impacts of the proposed Sabine-Neches Waterway Channel Improvement Project (SNWW CIP). The proposed SNWW CIP is intended to improve the efficiency of the deep-draft navigation system while protecting the area's environmental resources. The FEIS addresses the potential direct, indirect, and cumulative impacts of the proposed project on the human environment, as identified during the public interest review, including placement of dredged material. All factors that may be relevant to the proposed project were considered, including plans for construction and operations, dredged material management and opportunities for beneficial uses, hydrology, salinity, and storm surges, terrestrial and aquatic habitats, endangered species, essential fish habitat, hazardous materials, air quality, shoreline erosion, cultural resources, socioeconomic considerations, safety, and economic effects. The alternatives analysis evaluated the No-Action, 3 nonstructural, and 120 structural alternatives. A recommended plan was selected that would deepen the SNWW to Beaumont to 48 feet and extend the Sabine Bank Channel an additional 13.2 miles, taper the Sabine Bank Channel from 800 feet wide (Station 23+300) to 700 feet wide (Station 25+800) through the end of the Sabine Bank Channel extension, deepen and widen Taylor Bayou channels and turning basins, and construct 3 new anchorage/turning basins on the Neches River. Beneficial use features and mitigation measures have been developed that effectively avoid or mitigate all environmental impacts. The public response to the findings of the Draft EIS have been addressed in the FEIS.

Comments on this FEIS must be postmarked by April 4, 2011.

For further information, contact:
Janelle Stokes
U.S. Army Corps of Engineers, Galveston District
P.O. Box 1229
Galveston, Texas 77553-1229
Phone: 409.766.3039
e-mail: janelle.s.stokes@usace.army.mil

ES.1 INTRODUCTION AND AUTHORITY

The U.S. Army Corps of Engineers (USACE) has joined in an agreement with the Sabine Neches Navigation District (SNND) to prepare a Final Feasibility Report (FFR) and a Final Environmental Impact Statement (FEIS) for proposed improvements to the Sabine-Neches Waterway (SNWW). The proposed SNWW Channel Improvement Project (CIP) is intended to improve the efficiency of the deep-draft navigation system while protecting the area's coastal and estuarine resources. As authorized by the Senate Committee on Environment and Public Works Resolution, dated June 5, 1997, USACE has reviewed previous USACE reports on the SNWW and other pertinent reports to determine the feasibility of modifying the channels serving the Port of Beaumont and the Port of Port Arthur, Texas. The lead agency for the FEIS is USACE, with several cooperating agencies. This FEIS was prepared as required by the National Environmental Policy Act to present an evaluation of potential impacts associated with the proposed CIP.

ES.2 PURPOSE AND NEED

The purpose of the proposed CIP is to improve the transportation efficiency of the SNWW's deep-draft navigation system, while protecting the quality of the area's coastal and estuarine resources. Proposed channel improvements will support industry at ports within the SNWW navigation channel system, which are critical in the Nation's economy and military defense. Depth restrictions of the existing SNWW channel configuration and congestion in the channel prevent it from efficiently accommodating predicted future increases in crude oil imports. In addition to existing crude oil and petrochemical product facilities on the SNWW, one liquefied natural gas (LNG) facility began operations in 2008, and construction of a second facility is nearing completion; a third has received regulatory approval. In 2007, the Port of Beaumont handled about half of the military cargo deployed to and from the war in Iraq. The existing, congested SNWW cannot handle this level of increased use without compromising efficiency. Deep-draft vessels and barge traffic are restricted by narrow channel widths leading to constraints such as daylight-only and one-way sailing restrictions in specific reaches. Given the trend towards shorter, wider vessels and the congestion in the channel, deepening the channel could alleviate some of the congestion by allowing vessels to be more fully loaded and reducing the number of lightened and lightering vessels. The need to improve the SNWW must be weighed against the potential to affect significant environmental resources. The study area contains approximately 480 square miles of sensitive coastal habitats that are plagued by a high rate of wetland loss and extensive losses of interior coastal wetlands. These high rates of land loss provide opportunities to use dredged material beneficially for wetland restoration.

ES.3 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

Analysis of alternatives that could potentially meet the purpose and need for the proposed action included a systematic evaluation and consideration of environmental factors. Based on a three-phase screening process (preliminary screening, second screening, and final screening of alternatives), nonstructural and structural alternatives were identified and evaluated relative to a No-Action Alternative. The No-Action Alternative carried forward for evaluation provides a basis against which all other alternative plans are measured. Thus, under the No-Action Alternative, the Federal Government and the non-Federal sponsor would not implement the proposed CIP. The 40-foot SNWW navigation channel would not be improved, and the objectives of improving the navigational efficiency of the waterway would not be met. Additionally, under the No-Action Alternative, benefits associated with proposed beneficial uses of dredged material for the proposed CIP would be substantially reduced. Nonstructural alternatives evaluated were (1) an alternative mode of commodity transport (i.e., an offshore oil terminal), (2) a vessel traffic system, and (3) modification of pilot rules. None of these alternatives increased the efficiency objective for all waterway users and were eliminated from further consideration.

Through the three-phase screening process, over 120 different combinations of various channel depths and widths were considered, with six depths (45, 46, 47, 48, 49, and 50 feet) evaluated in detail. The detailed evaluation included an economic evaluation to identify alternatives that maximized National Economic Development (NED) benefits, consistent with protecting the environment. Project benefits were based on reductions in transportation costs generated from more-efficient vessel loading and from reductions in vessel delays. The width of the channel was evaluated with a vessel simulation model conducted by the USACE Engineer Research and Design Center (ERDC) with input from the Sabine Pilots Association. Following the selection of a preferred channel alternative, a detailed evaluation of alternatives for the management of dredged material and the mitigation of ecological impacts was conducted. Least-cost analysis of dredged material placement and an incremental cost analysis of mitigation alternatives were conducted to select recommended placement and mitigation measures. The analysis of alternative dredged material placement7 components was performed in conjunction with planning for the avoidance and mitigation of impacts from channel improvements so that dredged material could be given a priority for potential use in mitigation efforts. Dredged material placement alternatives considered in the detailed evaluation included:

- Neches River Beneficial Use (BU) Feature
- Gulf Shore BU Feature
- Existing Active and Inactive Upland Placement Features (PAs)
- New upland PAs
- Existing Ocean Dredged Material Disposal Sites (ODMDSs)
- New ODMDSs

The Preferred Alternative proposes to increase the authorized depth of the channel from 40 to 48 feet along the entire 64-mile-long existing channel and add a 13.2-mile extension to the offshore channels into the Gulf of Mexico. The offshore navigation channels, known collectively as the Entrance Channel, are divided into the Extension Channel, the Sabine Bank Channel, the Sabine Pass Outer Bar Channel, and the Sabine Pass Jetty Channel. They would be deepened from 42 to 50 feet. The inshore channels (the Sabine Pass Jetty Channel, Sabine Pass Channel, Port Arthur and Sabine-Neches canals, and the Neches

River Channel) would be deepened from 40 feet to 48 feet. No modifications to the existing Sabine Pass Jetties are contemplated in conjunction with this project. Potential rehabilitation of the jetties is currently being studied, with the goal of preparing a long-range plan of modification needed to ensure that the jetties continue to function appropriately to support the Federal navigation channel.

Except for the one channel reach just beyond the jetties, the bottom width of the offshore Entrance Channel would be 700 feet wide. Since the existing Sabine Bank Channel is 800 feet wide, the bottom width of the deepened channel would be reduced to 700 feet wide. However, high currents passing around the mouth of the jetties require that the bottom width of the Sabine Pass Outer Bar Channel remain 800 feet wide, and therefore the deepened channel would be tapered to connect to the 700-foot Entrance Channel. With the exception of the Taylor Bayou basins and channels, the inshore channels would retain their existing 500 to 400 foot widths. The Taylor Bayou basins and channels would be widened to improve maneuverability for vessels using that facility. Neither the Sabine-Neches Canal nor the Neches River Chanel would be systematically widened, but navigation efficiency would be improved with bend easings in both reaches and the addition or enlargement of turning and anchorage basins on the Neches River Channel. Project dimensions for the Preferred Alternative are provided in Table ES-1.

Table ES-1
Project Dimensions for Preferred Alternative

Reach	Station	to	Station	Bottom Width (feet)	Project Depth (feet)
Extension Channel	165+443		95+734	700	50
Sabine Bank Channel	95+734		25+800	700	50
Sabine Bank Channel	25+800		23+300	700–800	50
Sabine Bank Channel	23+300		18+000	800	50
Sabine Pass Outer Bar Channel	18+000		0+000	800	50
Sabine Pass Jetty Channel	–214+88		0+00	800–500	48
Sabine Pass Channel	0+00		296+25	1355–500	48
Port Arthur Canal	0+00		325+84	1660–500	48
Sabine-Neches Canal	0+00		592+94	1050–400	48
Neches River Channel	0+00		980+00	400–1413	48
Taylor Bayou					
Entrance Channel	0+00		25+27	406–764	48
East Turning Basin	0+00		17+65	532–354	48
West Turning Basin	25+27		41+30	776	48
Connecting Channel	41+30		71+50	470–250	48
Taylor Bayou Turning Basin	71+50		106+25	1000	48

A total of 104 pipelines have been identified crossing the SNWW navigation channels. Of the 104 pipelines, 46 require adjustment to meet the minimum required vertical and horizontal clearances for the SNWW CIP. Bridge supports for the Martin Luther King Bridge over the Sabine-Neches Canal would be hardened because of the proximity of the new channel cut; supports for the Rainbow and Veterans Memorial bridges would not be affected. Bridge fender systems for all three bridges would be removed and replaced to accommodate the new channel dimensions. The Port Arthur Hurricane Flood Protection Levee and utility power lines would not be affected.

Dredged material produced by construction of the Preferred Alternative and during maintenance dredging over the 50-year period of analysis would be managed in accordance with the Dredged Material Management Plan (DMMP). PAs proposed in the DMMP consist of upland PAs, ODMDSs, and BU features. Construction of the Preferred Alternative is expected to yield approximately 98 million cubic yards (mcy) of new-work dredged material. Maintenance dredging over the 50-year period of analysis is expected to yield approximately 650 mcy of dredged material. Dredged material will be placed in 16 existing upland PA features and 2 new expansion cells at existing upland PAs (18A and 24A). For the Entrance Channel, material will be placed in four existing and four proposed ODMDS features. Beneficial uses of dredged material in the DMMP consist of the Neches River BU Feature (Rose City East, Bessie Heights East, and Old River Cove) and the Gulf Shore BU Feature at Texas and Louisiana Points. Figures 2.4-1a–g in the FEIS show all the DMMP placement features proposed as part of the Preferred Alternative.

The Neches River and Gulf Shore BU features use dredged material beneficially to avoid and minimize all environmental impacts in Texas and some impacts in Louisiana. Compensatory mitigation in the form of marsh restoration is proposed for all unavoidable environmental impacts in Louisiana.

ES.4 POTENTIAL ENVIRONMENTAL IMPACTS

The FEIS addresses the potential impacts of the proposed project on human and environmental issues identified during the public interest review, including placement of dredged material. All factors that may be relevant to the proposed project were considered. Among those factors are salinity effects, effects to marshes and wetland forests, effects on threatened and endangered species, shoreline erosion, water and sediment quality, hazardous materials, air quality, cultural resources, socioeconomic effects, energy needs, safety, and in general, the welfare of the people of the United States. The following provides a brief description of potential impacts that were identified.

Physiography and Geology

Impacts on local geology during dredging and dredged material placement associated with the Preferred Alternative would include redistribution of existing sediment, potential increase of local scouring and shoaling rates, reduced erosion of inshore channel shorelines, and reduced erosion rates at Gulf shoreline nourishment areas compared to the No-Action Alternative. While local changes would occur to bathymetry and topography during construction and operation of the proposed project, these alterations would be expected to have negligible impacts on the regional physiography of the submerged and subaerial portions of the study area. No impacts associated with geologic hazards are expected, and impacts on local geology are expected to be minimal.

Water Quality

USACE has received Section 401 State Water Quality Certification from Texas and Louisiana for this action. Both states have determined that the requirements for water quality certification have been met and have concluded that the placement of fill material will not violate water quality standards of either state. The Preferred Alternative is the least environmentally damaging practicable alternative. It would result in little, if any, difference in long-term inland turbidity or dissolved oxygen levels when compared to the No-Action Alternative. Short-term increases in turbidity may be caused by the unconfined flow of dredged material during construction of BU features and mitigation measures. There would be temporary, minor impacts from ocean placement at the new ODMDSs. Proposed channel improvements should increase safety, thus decreasing the probability of a spill.

Sediment Quality

Surficial sediments to be dredged during construction of the offshore Extension Channel have been determined to be suitable for ocean placement. Additionally, shoaled sediments and the construction material that would be dredged from the SNWW during construction of the Preferred Alternative was determined to be of sufficient quality to be used for beneficial uses.

Although the quantity of maintenance material dredged from the inland reaches of the SNWW is expected to increase significantly compared to the No-Action Alternative, the source of the maintenance material would not change, and the method of placement would not change, except that more of the maintenance material would be used beneficially. Past testing of maintenance material has indicated no cause for concern.

Hydrology

Under the Preferred Alternative, there would be a deeper channel that would allow a greater amount of tidal circulation and exchange with the Gulf and cause only a minimal increase of water surface elevation. Salinity would increase in much of the system by a maximum of about 2 parts per thousand, and the salinity wedge in the SNWW navigation channel would extend farther upstream in the Neches River. It is not expected to have an effect on freshwater inflows to the Sabine-Neches system. However, because the amount of tidal exchange would be slightly increased, the inflows would be conveyed to the Gulf marginally faster than would be the case in the No-Action Alternative. In regards to sediment transport, the Preferred Alternative would slightly reduce the net westward littoral transport on the Texas side and the net eastern littoral transport on the Louisiana side. The changes in sediment transport, while very small, can be expected to have some effect on the rates of Gulf shoreline erosion. Under the Preferred Alternative, there is a slight increase in the Gulf shoreline erosion rate between 0.5 mile and 3.5 miles from each jetty, but shoreline nourishment in the DMMP would replace shoreline that would be lost. The Preferred Alternative should also reduce the rate of erosion on inland channels relative to the No-Action Alternative by reducing the number of predicted vessel trips.

Because clay barrier layers are anticipated to prevent contact between water or elutriate from construction and maintenance dredged material and groundwater, no adverse effects are anticipated to the lower unit of the Chicot, any portion of the Evangeline, or the massive portions of the upper Chicot aquifers. Therefore, no adverse effects are anticipated to occur to groundwater wells documented in the project area counties.

The potential for proposed project features to increase storm surge impacts in the study area was analyzed with a storm surge sensitivity analysis. The greatest changes would occur north of Port Arthur along the Neches River due primarily to the proposed increase in depth of the navigation channel. All changes are local, and there are no project-induced increases in surges away from the immediate vicinity of the navigation channel. Changes in peak surge on the order of inches could occur with the project but should not cause any significant change in interior flooding.

Hazardous, Toxic, and Radioactive Waste (HTRW)

Findings of the HTRW survey indicate that there may be potential for encountering contaminated material during construction of the project, especially near industrial facilities that have not yet completed remediation efforts. Encountering contaminated material could increase project cost and/or lost time. However, based upon recent chemical analyses of water and sediment collected from within the channels, the potential for encountering contaminated material during dredging operations is considered minimal. The potential for oil and gas wells and petroleum pipelines to impact the project area is also minimal. A capped landfill has been found in PA 17 that is unrelated to dredged material or dredging activities. Issues related to possibly hazardous materials in the landfill must be resolved by the non-Federal sponsor before the PA can be used. Alternate PAs are available should this issue not be resolved in time for use.

Air Quality

Construction activities associated with the proposed CIP would result in emissions from combustion products from project dredging, support, and reuse/disposal equipment. Pollutant emissions from construction and dredging activities may result in short-term impacts on air quality in the immediate vicinity of the project site. Emissions of volatile organic compounds for the activities subject to USACE responsibility are exempt from a General Conformity Determination because they are below the 100-ton-per-year (tpy) threshold. Estimated nitrogen oxide (NO_x) emissions for activities subject to USACE responsibility would exceed the conformity threshold of 100 tpy for all years of construction. Therefore, USACE prepared a General Conformity Determination for NO_x emissions, which was submitted to the Texas Commission on Environmental Quality (TCEQ), U.S. Environmental Protection Agency (EPA), and other air pollution control agencies, as appropriate, to ensure conformity of this project with the State Implementation Plan (SIP). The TCEQ has provided written concurrence that emissions from the Preferred Alternative are conformant with the Texas SIP for the Beaumont-Port Arthur region (Appendix A1). Based on the TCEQ's comments, the USACE has prepared a Final General Conformity Determination for the proposed SNWW CIP (Appendix F).

Noise

The Preferred Alternative is not expected to result in long-term noise impacts because no permanent noise sources would be installed as part of this project and elevated noise levels would be short term, occurring during construction and maintenance dredging activities. Short-term impacts could be considered potentially significant at noise-sensitive land uses within 600 feet of dredging activities. Elevated noise levels are expected to be no different from those currently experienced during maintenance dredging activities. Therefore, no increase in noise impacts over levels associated with the No-Action Alternative is expected.

Vegetation

The Preferred Alternative would either directly or indirectly impact more than 220,000 acres of aquatic habitats in Texas and Louisiana. In Texas, negative impacts to productivity would occur over approximately 39,000 acres with a resulting loss of 412 Average Annual Habitat Units (AAHUs). The majority (380 AAHUs) are indirect productivity impacts that would occur to approximately 33,500 acres of intertidal marsh and swamp due to small increases in salinity from the proposed channel deepening. Direct impacts (32 AAHUs) are associated with the conversion of 86 acres of fresh marsh to upland PA 24A.

In Louisiana, negative indirect impacts to productivity would occur to approximately 182,000 acres of intertidal marsh due to small increases in salinities from the proposed channel deepening. The resulting total loss would be 1,709 AAHUs. No productivity or land loss impacts to Louisiana swamps are expected to occur.

The DMMP BU features (Neches River BU Feature in Texas and the Gulf Shore BU Feature in both Texas and Louisiana) would provide benefits that offset all impacts (–412 AAHUs) of the proposed plan in Texas and partially offset impacts in Louisiana. In Texas, construction of the Neches River BU Feature and the Texas portion of the Gulf Shore BU Feature would produce benefits totaling 1,068 AAHUs. Therefore, there would be a net gain of 656 AAHUs, which more than offsets all negative impacts that would occur in Texas. In Louisiana, the Gulf Shore BU Feature would provide benefits totaling 210 AAHUs. Given total Louisiana impacts of 1,709 AAHUs, there would be a net loss of 1,499 remaining in Louisiana after offsetting benefits of the Louisiana portion of the Gulf Shore BU Feature are applied.

After benefits of the BU features are applied to the project as a whole, the Preferred Alternative would result in the loss of 843 AAHUs over the future with-project condition. However, because the ecological benefits of the DMMP BU features would be primarily in Texas, additional compensatory mitigation beyond the total project loss of 843 AAHUs is proposed so that impacts in Louisiana would be compensated in Louisiana. The additional mitigation in Louisiana would result in a net gain of 338 AAHUs for the project as a whole and compensate for all losses in Louisiana with the exception of losses that would occur to Federal lands in the Sabine National Wildlife Refuge (SNWR). Exclusion of the SNWR is based upon the definition of "coastal zone" in the Coastal Zone Management Act of 1972, as amended. "Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents (16 USC § 1453)." Impacts to the SNWR would be fully offset by the Texas BU feature benefits.

A 1,159 AAHU loss would occur on non-Federal lands in Louisiana after taking into consideration the benefits of the DMMP. To offset this loss, a mitigation plan has been developed that will provide an ecological gain of 1,181 AAHUs in Louisiana. The mitigation plan would restore 2,783 acres of emergent marsh, improve 957 acres of shallow-water habitat, and nourish 4,355 acres of existing marsh.

Aquatic Ecology

The Preferred Alternative includes beneficial uses of dredged material that would restore the marsh elevations in the Neches River BU Feature. This is a large-scale feature that consists of marsh restoration in these major components: Rose City East, Bessie Heights East, and Old River Cove. These BU features are likely to have short- and long-term effects on the existing open-water communities. Shallow water or emergent marsh habitat would replace a significant portion of the open-water currently within each marsh. The marsh degradation process, which would proceed unchecked in the No-Action Alternative, would eventually adversely affect fishery productivity, while the restored marshes would improve nursery habitat and nutrient availability.

The total quantity of maintenance material from the inshore channels is expected to increase by 14 percent over the existing project, resulting in a similar increase in the duration of each maintenance dredging cycle; no change in the frequency of dredging cycles is anticipated. The total maintenance dredging quantity from the offshore channels is expected to increase by 120 percent, due to the 13.2-mile offshore channel extension and a predicted increase in the shoaling rate in existing channels. The increase in channel length and dredged material quantity will require the creation of four new ODMDSs. The types of impacts to marine communities from the Preferred Alternative would be similar to maintenance dredging impacts expected for the No-Action Alternative, including short-term, localized increases in turbidity, which may reduce primary productivity. Proposed beneficial uses of dredged material that result in benefits to marshes in the study area would also benefit finfish and shellfish. Small increases in salinity expected to occur as a result of the Preferred Alternative are not expected to directly adversely affect fauna. Impacts to benthic organisms from dredging and placement of dredged material are not expected to be significant because recolonization is rapid, although the community composition in new PAs may be slightly different from pre-project conditions. The Preferred Alternative would temporarily and locally impact Essential Fish Habitat (EFH) species because of increased turbidity, although impacts are expected to be minimal. Concurrence was provided by National Marine Fisheries Service (NMFS) on March 8, 2010 (Appendix A3). In addition, the Preferred Alternative would result in net benefits to EFH through marsh creation and benefits to submerged aquatic vegetation. No Habitat Areas of Particular Concern are located in the study area. No adverse impacts to recreationally or commercially important aquatic species are expected, and no additional impacts with respect to ballast water are anticipated.

Construction of the Willow Bayou marsh mitigation areas would use material dredged from a 1.8-mile-long borrow trench parallel to the eastern shore of Sabine Lake. An access channel (approximately 8 miles long) would also be required for the dredge to travel from the Gulf Intracoastal Waterway near the mouth of the Sabine River to the borrow trench location. The exact locations of the borrow trench and access route would be determined in consultation with the Interagency Coordination Team after preconstruction, engineering, and design bottom surveys of potential locations. One-time impacts of the borrow trench and access channel dredging include a temporary increase in turbidity and the short-term loss of benthic fauna. No impacts to oyster reef are anticipated but a preconstruction survey of the borrow trench area would be performed to check this assumption. The probability that oyster reef will be found is very low. Salinities are too low in this area of Sabine Lake to support survival of oyster spat. In the small chance that reef is found, it would be small and localized and easily avoided by changing the access route at borrow area configuration. The common Sabine Lake circulation pattern is expected to prevent the development of hypoxic conditions in the borrow trench and transport Sabine River sediment to eventually fill the trench. Construction of the Black Bayou mitigation areas would use material from regular maintenance dredging of the Sabine River Channel and approximately 18 feet of material that has accumulated since construction of the 30-foot Lake Charles Deepwater Channel. The latter coincides with the Gulf Intracoastal Waterway between the Sabine River and Lake Charles, Louisiana. One-time impacts of both dredging operations would include a temporary increase in turbidity and short-term loss of benthic fauna. These mitigation areas would fully compensate impacts of the Preferred Alternative to the biological productivity of marshes in the affected area. The dredging activities needed to construct the mitigation areas are expected to have a net beneficial effect and cause no long-term impacts to biological resources and estuarine aquatic habitats. Long-term benefits of a higher, more-stable marsh in the mitigation areas would more than offset short-term impacts to turbidity and benthic organisms.

Wildlife

Direct impacts to wildlife from implementation of the Preferred Alternative include dredging impacts to bottom-feeding and pelagic organisms such as sea turtles, loss of habitat from one new placement area, and temporary impacts to shorebirds and their habitat from the regular placement of maintenance material on the Gulf shoreline. Indirect impacts to wildlife related to dredging and placement activities include a reduction of shorebird food supply from short-term increases in turbidity, risk of oil, chemical, or other hazardous material spill during construction, and temporary noise disturbances. However, beneficial uses of dredged material resulting in additional marsh habitat and beach nourishment would provide additional habitat for wildlife in the area.

Threatened and Endangered Species

Hopper dredging of the Entrance Channel is likely to adversely affect but not jeopardize the continued existence of loggerhead, Kemp's ridley, hawksbill, and green sea turtles. In the Biological Opinion (BO), the NMFS authorized the incidental lethal take of four sea turtles and identified reasonable and prudent measures to be adopted during construction. Potential impacts to sea turtles from maintenance dredging are covered by the Gulf Regional BO for USACE's dredging activities. Critical Habitat for wintering piping plovers is present in the Louisiana portion of the Gulf Shore BU Feature. The U.S. Fish and Wildlife Service (USFWS) has concurred that the BU feature may affect, but is not likely to adversely affect, the species or its Critical Habitat because the Gulf Shore BU Feature would protect existing Critical Habitat. No other adverse effects to threatened and endangered plant or animal species have been identified.

Cultural Resources

While no specific impacts to historic properties have been identified at this time, the Preferred Alternative has the potential to adversely affect significant historic properties because numerous prehistoric and historic sites, structures, and shipwrecks are present in the project vicinity. A Historic Properties Programmatic Agreement has been negotiated and executed with the Texas and Louisiana State Historic Preservation Officers to ensure that significant historic properties are identified and mitigation, if necessary, is completed prior to project construction.

Socioeconomic Resources

Potential impacts to socioeconomic resources from the Preferred Alternative are not expected to be significant. Small changes in population growth are expected to occur as a result of the proposed CIP, and no disproportionately high or adverse impacts are expected to occur to minority or low-income persons. Development is likely to continue at the current rate resulting in no impacts to community values or housing in the study area, although land use patterns along the SNWW may change slightly in response to channel improvements. No negative impacts to the local economy are anticipated as a result of the Preferred Alternative, and the types of employment opportunities available in the area are not expected to change from current trends. No negative impacts are expected to occur to recreational resources or aesthetics within the study area.

Cumulative Impacts

Several past, present, and reasonably foreseeable future actions within the study area were identified for inclusion in the cumulative impacts analysis. Resources considered in the analysis included biological, ecological, physical, chemical, cultural, and socioeconomic resources for projects within the SNWW study area. Cumulative impacts from past, existing, and reasonably foreseeable projects, along with the Preferred Alternative, are not expected to have significant adverse effects within the study area. Impacts associated with the Preferred Alternative have been avoided or minimized by DMMP BU features or fully compensated by mitigation.

ES.5 AREAS OF CONTROVERSY AND UNRESOLVED ISSUES

USACE has evaluated the proposed SNWW CIP for consistency with the Louisiana coastal management program, and concluded that the Recommended Plan is fully consistent to the maximum extent practicable with the enforceable policies of the state's coastal management program. The Louisiana Department of Natural Resources (LDNR), Office of Coastal Management (OCM), found that the

SNWW CIP is conditionally consistent with their state program. Since conditional consistency as proposed by LDNR-OCM is not acceptable, LDNR-OCM has been notified that USACE will proceed with the project. This issue is discussed in detail in Section 6.0.

USACE coordination with the Louisiana Department of Wildlife and Fisheries (LDWF) has not been able to resolve issues related to the offset of project impacts to Federal lands with benefits from BU features in Texas, Louisiana Department of Wildlife and Fisheries (LDWF) requirements that the Recommended Plan include additional BU features, and royalty, license, and further assessment requirements concerning areas in Sabine Lake that would be affected by the removal of fill material for use in marsh mitigation. USACE has proposed that an assessment survey be completed, following the protocol established by LDWF, during the preconstruction, engineering, and design phase of the SNWW CIP.

In order for the four new ODMDSs to be approved for use, the EPA must publish a final rulemaking in the Federal Register. An FEIS for the proposed ODMDS and a Final Site Management and Monitoring Plan have been prepared and accepted by EPA for use in this rulemaking at a later date (Appendix B of the FEIS).

Coordination is ongoing with the Texas Point and Sabine National Wildlife refuges regarding construction activities related to the Gulf Shore BU Feature and proposed compensatory mitigation measures. The USFWS must determine whether these activities are compatible with the purposes of the refuges.

Issues related to hazardous materials in PA 17 (a capped landfill and other waste disposal areas within the PA) must be resolved by the non-Federal sponsor before the PA can be used as part of the Preferred Alternative. Alternative placement areas are available should PA 17 not be available for use.

ES.6 RELATION TO ENVIRONMENTAL REQUIREMENTS

The Preferred Alternative is in full compliance with the environmental requirements applicable to this stage of the planning process. A discussion of the applicable laws can be found in Chapter 7 of the FEIS.

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Acronyms and Abbreviations

μg/L	micrograms per liter
$\mu g/m^3$	micrograms per cubic meter
°F	degrees Fahrenheit
AAHU	Average Annual Habitat Unit
AIRData	Aerometric Information Retrieval Database
AIS	Automatic Identification System
AOA	air operations area
AOU	American Ornithologists' Union
AQCR	Air Quality Control Region
B.C.E.	Before the Common Era
B.P.	before present
BA	Biological Assessment
BEG	Bureau of Economic Geology
BHM	Bottomland Hardwood Model
BO	Biological Opinion
BOOTS	Bulk Oil Offshore Transfer System
BPA	Beaumont-Port Arthur
BU	Beneficial Use
C.E.	Common Era
CAA	Clean Air Act
CAP	Continuing Authorities Program
CAR	Coordination Act Report
CBD	central business district
CBRA	Coastal Barrier Resources Act
CCP	Comprehensive Conservation Plan
CE/ICA	cost effective/incremental cost analysis
CEPRA	Texas Coastal Erosion Planning and Response Program
CEQ	President's Council on Environmental Quality
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CERCLIS	Comprehensive Environmental Response Compensation and Liability Information System
CFR	U.S. Code of Federal Regulations
cfs	cubic feet per second
CHL	Engineering Research and Development Center's Coastal and Hydraulic Laboratory
CIP	Channel Improvement Project
CMP	Coastal Management Program
CNRA	coastal natural resource area
CO	carbon monoxide
CORRACT	Resource Conservation and Recovery Act Corrective Actions List
CW	Contaminants Workgroup
CWA	Clean Water Act
CWPPRA	Coastal Wetlands Planning, Protection and Restoration Act

cy	cubic yards
CZMA	Coastal Zone Management Act
CZMP	Coastal Zone Management Plan
dB	decibel
dBA	A-weighted sound level
dbh	diameter at breast height
DEIS	Draft Environmental Impact Statement
DMMP	Dredged Material Management Plan
DMPA	Dredged Material Placement Area
DO	dissolved oxygen
DWT	dead weight tons
EC	Engineer Circular
EFH	Essential Fish Habitat
EH&A	Espey, Huston & Associates, Inc.
EIS	Environmental Impact Statement
EJ	Environmental Justice
EMCM	Emergent Marsh Community Model
EnvWG	Environmental Workgroup
EO	Executive Order
EPA	U.S. Environmental Protection Agency
ER	Engineer Regulation
ERDC	Engineering Research and Development Center
ERL	Effects Range Low
ERNS	Emergency Response Notification System
ESA	Endangered Species Act
ETJ	extraterritorial jurisdiction
ETRW	East Texas Regional Water
FERC	Federal Energy Regulatory Commission
FFR	Final Feasibility Report
FHWA	Federal Highway Administration
FINDS	Facility Index System
FONSI	Finding of No Significant Impact
FR	Federal Register
FWOP	future without-project
FWP	future with-project
GEC	Gulf Engineers and Consultants, Inc.
GIS	Geographic Information System
GIWW	Gulf Intracoastal Waterway
GLO	General Land Office
GMFMC	Gulf of Mexico Fishery Management Council
GNF	general navigation features
GSMFC	Gulf States Marine Fisheries Commission
GTCBT	Great Texas Coastal Birding Trail
Gulf	Gulf of Mexico

HAPC	Habitat Areas of Particular Concern
HEP	Habitat Evaluation Procedure
HHS	Department of Health and Human Services
HPPA	Historic Properties Programmatic Agreement
HS	hydrodynamic salinity
HSI	Habitat Suitability Index
HTRW	Hazardous, Toxic, and Radioactive Waste
HU	Hydrologic Unit, Hydro-Unit
HW	Habitat Evaluation Workgroup
ICT	Interagency Coordination Team
IH	interstate highway
IPCC	Intergovernmental Panel on Climate Change
ISO	Insurance Services Office
ITM	Inland Testing Manual
IWR-WCUS	Institute of Water Resources-Waterborne Commerce of the U.S.
JCDD6	Jefferson County Drainage District No. 6
JCND	Jefferson County Navigation District
JCWND	Jefferson County Waterway and Navigation District
LBG and TEA	Louis Berger Group and Toxicological & Environmental Associates
LC_{50}	the concentration of a substance that is lethal to 50 percent of test organisms after a continuous exposure of 96 hours
LCA	Louisiana Coastal Areas
LCMP	Louisiana Coastal Management Program
LCPRA	Louisiana Coastal Protection and Restoration Authority
LCWCR/WCRA	Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority
LDA	Louisiana Division of Archaeology
LDEQ	Louisiana Department of Environmental Quality
L_{dn}	Day-night Sound Level
LDNR	Louisiana Department of Natural Resources
LDOL	Louisiana Department of Labor
LDWF	Louisiana Department of Wildlife and Fisheries
L_{eq}	equivalent sound level
LERR	lands, easements, rights-of-way, and relocation
LNG	Liquefied Natural Gas
LNVA	Lower Neches Valley Authority
LOOP	Louisiana Offshore Oil Port
LUST	leaking underground storage tank
LWQS	Louisiana Surface Water Quality Standards
mcy	million cubic yards
mg/kg	milligrams per kilogram
mg/L	milligrams per liter
MGD	million gallons per day
MLK	Martin Luther King
MLLW	mean lower low water

MLT	mean low tide
mm	millimeters
MMS	Minerals Management Service
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSA	Metropolitan Statistical Area
MSFCMA	Magnuson-Stevens Fishery Conservation and Management Act
MW	Modeling Workgroup
NAAQS	National Ambient Air Quality Standards
NAWMP	North American Waterfowl Management Plan
NBIC	National Ballast Information Clearinghouse
NDD	Natural Diversity Database
NED	National Economic Development
NEPA	National Environmental Policy Act
NFWL	National Fish and Wildlife Laboratory
NGA	Natural Gas Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NO	nitric oxide
NO_2	nitrogen dioxide
NOAA	National Oceanic and Atmospheric Administration
NO_x	nitrogen oxides
NPDES	National Pollution Discharge Elimination System
NPL	National Priority List
NPS	National Park Service
NRC	National Research Council
NRCS	Natural Resources Conservation Service
NRHP	National Register of Historic Places
NWI	National Wetlands Inventory
NWR	National Wildlife Refuge
NWRC	National Wetlands Research Center
O&M	Operation and Maintenance
O_3	ozone
OCM	Office of Coastal Management
ODMDS	Ocean Dredged Material Disposal Site
OW	ODMDS Workgroup
PA	Placement Area
PADD	Petroleum Administration Defense District
PAH	polycyclic aromatic hydrocarbons
Pb	lead
PCBs	polychlorinated biphenyls
PCP	pentachlorophenol
PED	preconstruction, engineering, and design
PM	particulate matter
PM_{10}	inhalable particulate matter <10 microns in diameter

$PM_{2.5}$	fine particulate matter ≤2.5 microns in diameter
ppm	parts per million
ppt	parts per thousand
RCRA	Resource Conservation and Recovery Act
RIA	Regional Implementation Agreement
RRC	Texas Railroad Commission
RSLR	relative sea level rise
RSM	Regional Sediment Management
RW	Restoration and Beneficial Uses Workgroup
SAL	State Archeological Landmark
SAV	submerged aquatic vegetation
SCM	Swamp Community Model
SETWAC	Southeast Texas Waterways Advisory Council
SH	State Highway
SHPO	State Historic Preservation Officer
SI	Suitability indices
SIP	State Implementation Plan
SMMP	Site Monitoring and Management Plan
SNND	Sabine Neches Navigation District
SNWW	Sabine-Neches Waterway
SO_2	sulfur dioxide
SOC	Species of Concern
SP	State percentage
SRA-LA	Sabine River Authority of Louisiana
SRA-TX	Sabine River Authority of Texas
SWL	solid waste landfill
SWQM	Standard Water Quality Monitoring
TCEQ	Texas Commission on Environmental Quality (formerly TNRCC)
TCMP	Texas Coastal Management Program
TCOON	Texas Coast Ocean Observation Network
TDS	total dissolved solids
TDSHS	Texas Department of State Health Services
TLO	Texas Legislature Online
TNHP	Texas Natural Heritage Program
TNRCC	Texas Natural Resource Conservation Commission
TOC	total organic carbon
TPH	total petroleum hydrocarbon
TPWD	Texas Parks and Wildlife Department
tpy	tons per year
TRIS	Toxic Release Inventory System
TSS	total suspended solids
TVS	total volatile solids
TWC	Texas Workforce Commission
TWDB	Texas Water Development Board

TWQS	Texas Surface Water Quality Standards
TxDOT	Texas Department of Transportation
ULCC	Ultra Large Crude Carriers
USACE	U.S. Army Corps of Engineers
USCCSP	U.S. Climate Change Science Program
USCG	U.S. Coast Guard
USDC	U.S. Department of Commerce
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VFD	volunteer fire department
VLCC	Very Large Crude Carriers
VOC	volatile organic compound
VTS	Vessel Traffic Service
WAM	Water Availability Models
WMA	Wildlife Management Area
WQC	water quality criteria
WQS	water quality standards
WRDA	Water Resources Development Act
WVA	Wetland Value Assessment

1.0 NEED FOR AND OBJECTIVES OF ACTION

This chapter is divided into seven sections. Section 1.1 provides information on study authorities, project sponsors, cooperating agencies, and the location of the proposed project. Section 1.2 explains the purpose for, and need of, the proposed project, and Section 1.3 describes the existing project. Section 1.4 summarizes problems, needs, and concerns expressed by the public, resource agencies, and local governments at scoping meetings early in the study. Section 1.5 identifies planning objectives for the feasibility study, and Section 1.6 describes the resource agency coordination process and team. The chapter concludes in Section 1.7 with a description of resource management opportunities for dredged material.

1.1 STUDY AUTHORITY AND LOCATION

The Senate Committee on Environment and Public Works Resolution, dated June 5, 1997, authorized the U.S. Army Corps of Engineers (USACE) to review previous USACE reports on the Sabine-Neches Waterway and other pertinent reports to determine the feasibility of modifying the channels serving the Ports of Beaumont, Port Arthur, and Orange, Texas, in the interests of commercial navigation. These channels are collectively named the Sabine-Neches Waterway (SNWW). The Jefferson County Navigation District (JCND), non-Federal sponsor of the existing channels to Beaumont and Port Arthur, requested that the USACE initiate a reconnaissance study of potential channel improvements in September 1998. The reconnaissance investigation resulted in a finding that there was a Federal interest in the project and recommended that the study be continued into the feasibility phase. The JCND expressed its intent to act as the non-Federal sponsor for this phase of the study. The Final Feasibility Report (FFR) for the Sabine-Neches Waterway Channel Improvement Project (SNWW CIP) will determine whether improvements to the existing Federal navigation project are justified, and provide documentation needed to request Congressional authorization and funding for construction of the project. The Sabine River Channel to Orange, Texas, was not included in this FFR due to expectations of continued low utilization of the existing 30-foot channel. In 2002, the JCND was renamed the Jefferson County Waterway and Navigation District (JCWND), and in 2007, the JCWND was renamed the Sabine Neches Navigation District (SNND); the latter designation is used throughout the remainder of this document.

In March 2000, USACE and JCND signed an agreement to prepare an FFR and a Final Environmental Impact Statement (FEIS) for the proposed CIP. The lead agency for the FEIS is the USACE, with several cooperating agencies (Appendix A1). The U.S. Environmental Protection Agency (EPA) has agreed to be a cooperating agency for purposes relating to its authority to designate Ocean Dredged Material Disposal Sites (ODMDSs). The ODMDS FEIS, attached as Appendix B, provides the environmental analysis and public review required for subsequent EPA site designation. The National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), Texas General Land Office (GLO), and Louisiana Department of Wildlife and Fisheries (LDWF) have agreed to be cooperating agencies with participation limited to meetings, teleconferences, and report review. The cost of the FFR and FEIS is shared by the USACE and the JCND.

The SNWW is located on the upper Texas Gulf Coast at the Texas-Louisiana state boundary (Figure 1.1-1). Sabine Pass, Sabine Lake, and the Sabine River together form the southern section of the boundary between the two states. The area surrounding the waterway is generally referred to as the "Golden Triangle," which refers to the metropolitan area's three major cities and their ports—Beaumont, Port Arthur, and Orange, Texas. The "Golden" refers to the wealth that came from the Spindletop oil strike in Beaumont in 1901. Several smaller cities also are located in the Golden Triangle, including Nederland, Port Neches, Groves, Bridge City, Vidor, and the City of Sabine Pass.

The project area is defined as those areas that will be directly affected by construction of the CIP, i.e., the proposed dredging footprint, existing and proposed placement areas (PAs) identified in the Dredged Material Management Plan (DMMP), and mitigation areas. The CIP refers to proposed plans for navigation improvements. Details of the Preferred Alternative for these improvements are provided in Section 2.4.

The study area includes a larger area for which environmental effects of alternatives have been analyzed (Figure 1.1-2). The study area encompasses a 2,000-square-mile area that contains the smaller project area and includes the following waterbodies and adjacent coastal wetlands: Sabine Lake and adjacent marshes in Texas and Louisiana, the Neches River Channel up to the Neches River Saltwater Barrier, the Sabine River Channel to the Sabine Island Wildlife Management Area (WMA), the Gulf Intracoastal Waterway (GIWW) west to Star Bayou, the GIWW east to Gum Cove Ridge, the Gulf of Mexico (Gulf) shoreline extending to 10 miles either side of Sabine Pass, and 35 miles offshore into the Gulf.

1.2 PURPOSE AND NEED

The purpose of the proposed CIP is to improve the transportation efficiency of the SNWW's deep-draft navigation system, while protecting the quality of the area's coastal and estuarine resources. Channel improvements are needed to support the SNWW's critically important role in the Nation's economy. In 2007, the SNWW ranked 4th in the Nation in total tonnage, importing 141 million short tons (Institute of Water Resources-Waterborne Commerce of the U.S. [IWR-WCUS], 2007). Individually, the Port of Beaumont ranked 5th nationally for domestic and total tonnage, and the Port of Port Arthur ranked 28th in the Nation (IWR-WCUS, 2007).

The Port of Beaumont's public docks are located on the Neches River Channel, as well as several crude petroleum and product terminals. Port Arthur's general cargo facilities are located on the Sabine-Neches Canal, and its crude petroleum and product terminals are located in the Taylor Bayou Basins. The Taylor Bayou Basins are located immediately south of Port Arthur at the junction of the Sabine-Neches Canal with the GIWW. In addition to its deep-draft traffic, the Sabine-Neches Canal serves as a through channel for shallow-draft barge traffic on the GIWW.

Sixty percent of the SNWW tonnage total comprises deep-draft movements, and the remaining 40 percent is shallow-draft GIWW traffic. There are 20 waterfront facilities in Port Arthur and 27 in Beaumont that receive and/or ship crude petroleum or petroleum/chemical products, making up the vast majority of

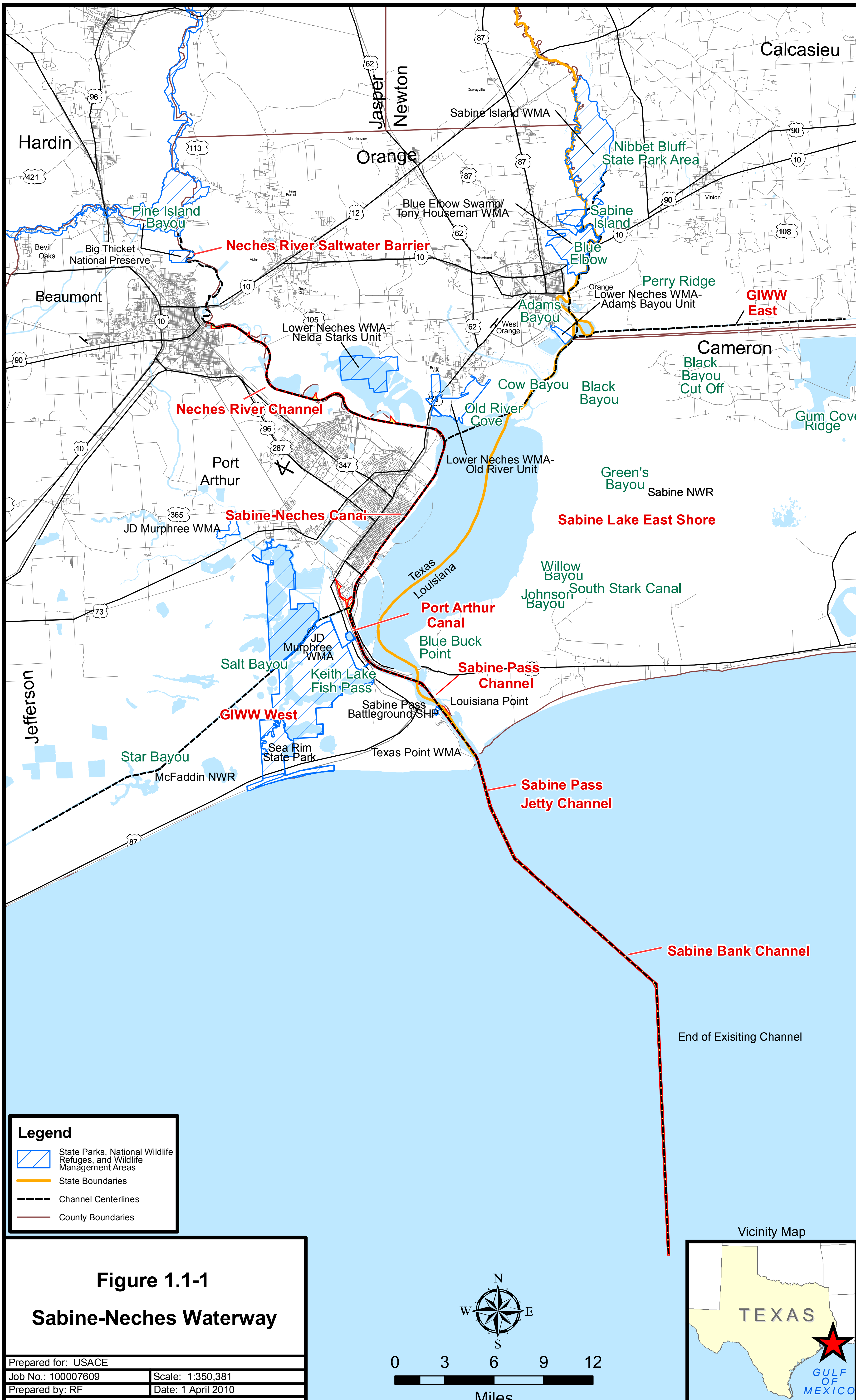

Figure 1.1-1

Sabine-Neches Waterway

Prepared for: USACE
Job No.: 100007609 | Scale: 1:350,381
Prepared by: RF | Date: 1 April 2010
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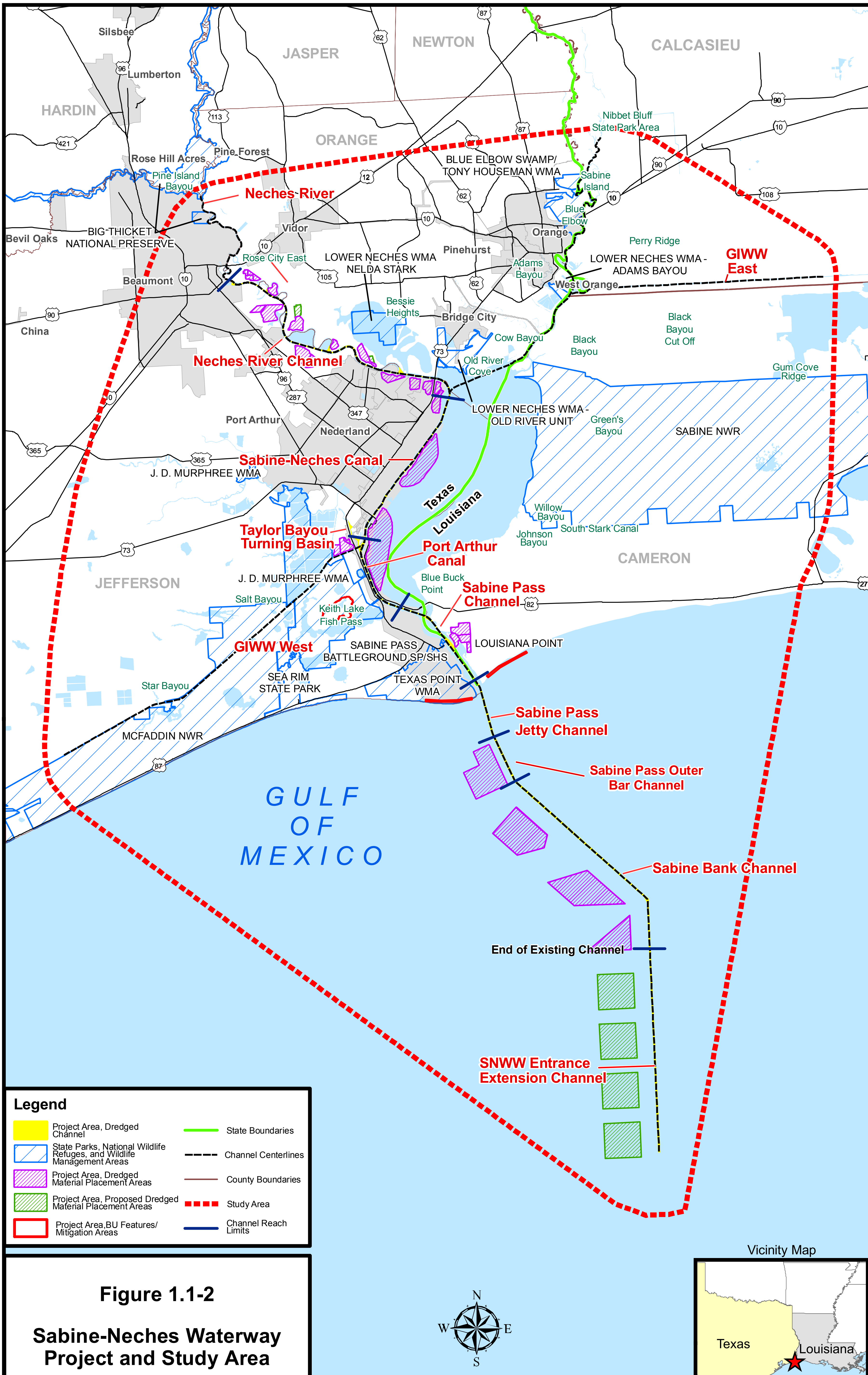

Figure 1.1-2

Sabine-Neches Waterway Project and Study Area

Prepared for: USACE	
Job No.: 100007609	Scale: 1" = 6 miles
Prepared by: RF	Date: 1 April 2010

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deep-draft movements on the waterway. The SNWW refineries also supply crude oil to the U.S. Department of Energy's "Big Hill Site" in Texas and the "Hackberry Site" in the Louisiana Strategic Petroleum Reserve. The waterway is the primary means of delivery for crude oil to four major refineries in Beaumont and Port Arthur. Domestic refineries on the Gulf Coast, the East Coast, and in the Midwest rely on the SNWW for 12 to 16 percent of waterborne crude oil deliveries (Martin Associates, 2006). Refined petroleum products are shipped from the SNWW via three major pipeline systems to 21 states east of the Rockies, including states as far away as Delaware, New Jersey, and Indiana. Other significant commodities and break bulk cargoes that are handled by the SNWW ports include petroleum coke, ammonia, sulphuric acid, metallic salts, liquid sulphur, bulk grain, manufactured iron and steel products, limestone, sand and gravel, and liquefied natural gas (LNG).

The SNWW's crude petroleum imports represent 4 percent of the U.S. total and 7 percent of the U.S. Western Gulf Coast region. From 1992 through 2005, crude petroleum imports on the SNWW grew at a 7.0 percent compound annual rate, compared to a 3.6 percent growth rate for the U.S. as a whole. Overall, commodity and breakbulk tonnage for the SNWW ports has also increased over this period. Grain exports have increased marginally since the middle 1990s, and Beaumont's 2005 to 2007 wheat exports represent 5 percent of the U.S. total. The waterway imported 14 percent of 2005 to 2007 U.S. pulp and waste paper products. Approximately 10 percent of 2005 to 2007 U.S. fertilizer and fertilizer mixes were exported from Beaumont.

During the early 2000s, permits were approved for Cheniere Energy's Sabine Pass, Exxon-Mobil's Golden Pass, and Sempra's Port Arthur LNG terminals. Construction of the Sabine Pass terminal was completed in April 2008 and operations began in April 2008. The Golden Pass LNG terminal was scheduled for completion in mid-2010 but has been delayed due to Hurricane Ike cleanup activities. Construction of the permitted Port Arthur facility is dependent upon the finalization of commercial arrangements. The SNWW LNG facilities are located in the Sabine Pass Channel and Port Arthur Canal; these reaches are presently 500 feet wide and would remain so in the without-project future. LNG vessels using the SNWW would be subject to strict U.S. Coast Guard (USCG) regulations and to local pilot rules, and all LNG vessel movements would be subject to one-way traffic. Since the Sabine Pass terminal opened, throughput has been low due to increased demand in other parts of the world. Long-term expectations are for prices to stabilize and shipments to the U.S. to increase, as LNG is expected to play an increasingly important role in the natural gas industry and global energy markets in the near and long-term future. The U.S. Energy Information Administration has raised its projections for LNG imports in 2009, citing falling demand elsewhere as new global production comes online.

The existing SNWW navigation channel system is congested. The existing 40-foot project depth was designed to efficiently and safely accommodate much smaller vessels than are being used today. The current 40-foot channel was completed in the late 1960s, and at that time, crude oil tankers averaging 40,000 dead weight tons (DWT) with loaded drafts of 36 feet were common. Vessels over 90,000 DWT are now used routinely for crude oil imports to both Beaumont and Port Arthur. In addition to larger vessels, the amount of vessel traffic on the SNWW has also increased. Both the SNWW and U.S. crude oil imports have risen steadily since the 1970s. The SNWW's 2002 to 2006 crude petroleum waterborne imports comprised 12 percent of U.S. and 18 percent of Western Gulf Coast imports. The SNWW capacity presently represents 6 percent of the U.S. total. The SNWW capacity levels for 2009 were 12 percent higher than in 2004, and 31 percent higher than in 1994. Recent increases in the SNWW refinery capacity indicate that the region will gain an increasing share of U.S. totals.

With the current channel depth, there are draft restrictions on large vessels currently utilizing the channel. A majority of the tonnage carried on the SNWW is in deep-draft vessels, and the vast majority of the deep-draft traffic is composed of crude oil and petrochemical products. However, LNG, grain, and aggregate products, such as iron ore, steel slab, limestone, sand, and gravel, are also carried in draft-constrained deep-draft vessels. Currently at the SNWW, very large crude carriers transfer tonnage at an offshore location onto one or more shuttle vessels in a process called lightering. These very large carriers cannot enter the SNWW because of their size and draft. In addition, other large crude tankers presently offload a partial load offshore to a shuttle vessel or vessels, a process called lightening. These vessels then enter the SNWW with the shuttle vessels as they are small enough to navigate the SNWW with a lighter load.

The SNWW experienced strong growth over the past decade, with total tonnage increasing from an average of 102 million short tons for 1994 to 1996 to 141 million for 2004 to 2006. As imports have increased, the number of lightering and lightened vessels and product carriers has also increased, adding to shipping delays and congestion. The total number of inbound vessels on the SNWW is projected to increase in the short term at rates comparable to or higher than regional and national trends. Recent increases in the SNWW refinery capacity indicate the region will regain an increasing share of U.S. totals.

Ships are not only requiring deeper drafts, but the sizes of the vessels are wider. The vessel beams of both Port Arthur's and Beaumont's vessels cause them to be regularly impacted by the present 500-foot width of the Sabine Pass Jetty Channel and Port Arthur Canal. The most common crude oil tankers unloading at the Taylor Bayou Basins have design drafts of 45 feet and beams of approximately 124 feet. Tankers using the Taylor Bayou Basins are smaller than those offloading at terminals on the Neches River Channel because existing width at the mouth of Taylor Bayou, and the configuration of the docks within Taylor Bayou, limits the allowable vessel size. The maximum size vessels unloading at Port of Beaumont facilities on the Neches River Channel are approximately 900 feet long, with a beam width of 164 feet.

The Sabine Pilots Association has adopted transit rules to deal with the narrow channel, and these rules result in navigation constraints. These constraints include daylight-only and one-way sailing restrictions in specific reaches. The main restrictions place limitations on the combined beam widths and drafts for vessel meetings on the waterway. A major restriction is that vessels with combined beam widths in excess of 50 percent of the channel width cannot meet. The effects of these and other navigation restrictions cause significant delays along the waterway.

As a result of these rules, inbound vessels intending to use a specific dock must wait offshore until the outbound vessel at that dock sets sail, resulting in considerable delays because of the length of the inshore channel. In addition, vessels are now wider due to new double-hull requirements and to industry changes to wider but shorter vessels, which makes vessel-meetings more difficult. The probability of accidents and other safety problems may increase with increases in both inland barge and deep-draft vessel traffic along the waterway. Channel deepening and additional turning and anchorage basins on the Neches River Channel could alleviate some of these congestion problems by permitting existing vessels to carry more cargo into port and reduce offshore vessel waiting times.

Congestion is increased during times when the SNWW serves an important military function. One of the busiest ports for military cargo in the world is located on the SNWW. The Port of Beaumont is the Nation's busiest Strategic Port of Embarkation, and it is the second largest commercial military out-load port worldwide. For the war in Iraq, it has handled approximately one-third of all the military cargo deployed to and from the war, which is more military cargo than any other U.S. port (Military Surface Deployment and Distribution Command, 2004, 2006). The SNWW must accommodate the military's increased use of newer and larger transport ships, which are three times the size of transport ships used in 1990. The SNWW contributes to national security in one other key aspect. Two terminals on the Neches River are connected by pipelines to underground storage facilities of the U.S. Department of Energy's Strategic Petroleum Reserves at Big Hill, Texas, and West Hackberry, Louisiana.

The need for improvements to the SNWW must be weighed against possible effects to significant environmental resources. The study area contains approximately 480 square miles of sensitive coastal habitats, which have experienced a high rate of wetland loss in recent decades. In Louisiana, a net land loss of 18 percent between 1978 and 2000 has been reported in the western Chenier Plain. In Texas, the most extensive losses of interior coastal wetlands in the state have occurred in the Neches River delta. Ninety percent of the emergent marshes in the Lower Neches River delta have been converted to open water, which is more than half of the total wetland loss in the State of Texas. These high land-loss rates provide opportunities for wetland restoration with the beneficial use of dredged material.

1.3 EXISTING PROJECT

The existing 40-foot SNWW project is a federally authorized and maintained waterway located in Jefferson and Orange counties, Texas, and Cameron and Calcasieu parishes, Louisiana (see Figure 1.1-1). However, the Sabine River Channel segment of the SNWW, which provides deep-draft access to the Port of Orange, is not included in the FFR. All subsequent references to the SNWW in this report focus on the 64-mile-long channel flowing through Jefferson and Orange counties, Texas, and Cameron Parish, Louisiana. The SNWW begins offshore, follows the west side of Sabine Lake and terminates just upstream of the Beaumont Turning Basin on the Neches River.

The SNWW is a system of widened and/or deepened channels (Table 1.3-1). Working inland from the Gulf, the reaches are (1) Sabine Bank Channel, (2) Sabine Pass Outer Bar Channel, (3) Sabine Pass Jetty Channel, (4) Sabine Pass Channel, (5) Port Arthur Canal, (6) Sabine-Neches Canal, and (7) Neches River Channel. The Sabine Bank through the Sabine Pass Jetty channels is sometimes referred to collectively as the Entrance Channel. The only connection with the Gulf is Sabine Pass, a long narrow pass, through which all tidal interchange occurs. The East and West Jetties extend approximately 4.1 miles into the

Gulf. They stabilize the Pass and provide protection for ships entering the landlocked channel. Maintenance material is placed in 16 upland confined PAs and 4 ODMDSs in the Gulf. The FFR and DMMP (Appendix D) provide more-detailed descriptions and maps of the existing navigation channels and PAs.

Table 1.3-1
Existing SNWW Channel Dimensions

Channel Reach	Authorized Depth (feet)	Bottom Width (feet)	Length (miles)
Sabine Bank Channel	42	800	14.7
Sabine Pass Outer Bar	42	800	3.4
Sabine Pass Jetty Channel	40	800–500	4.0
Sabine Pass Channel	40	500–1133	5.6
Port Arthur Canal	40	500–1788	6.2
Sabine-Neches Canal	40	400–1060	11.3
Neches River Channel	40	400	18.6

In addition to deep-draft traffic, the SNWW serves as a through-channel for the shallow-draft GIWW. As it leaves Louisiana, the GIWW connects with the SNWW, approximately 3 miles below Orange, Texas, and follows the Sabine River Channel to Sabine Lake. The GIWW and Sabine River Channel cross the north end of Sabine Lake where they merge with the Sabine-Neches Canal at the mouth of the Neches River. The GIWW and Sabine-Neches Canal coincide through the confined channel reach between Pleasure Island and Port Arthur, where the GIWW connects with the Port Arthur Canal and exits the SNWW, continuing westward to Galveston Bay.

1.4 PROBLEMS, NEEDS, AND PUBLIC CONCERNS

To be responsive to the needs and concerns of all stakeholders and to ensure public involvement through an open, interactive process, the USACE and SNND developed a public involvement plan to be used during the feasibility phase of the SNWW CIP. The public outreach program was initiated in 2000 and included the following efforts:

- scoping meetings;
- public environmental restoration and beneficial use workshops;
- media trips;
- presentations at the Gulf of Mexico Fishery Management Council (GMFMC) Texas Habitat Protection Advisory Board;
- presentations at Southeast Texas Waterways Advisory Council (SETWAC) regular meetings;
- meetings with Sabine Pilots Association;
- presentation at the SETWAC 2007 meeting;
- meetings with SNWW industries; and

- public hearings.

A Notice of Intent to prepare a "Draft Environmental Impact Statement for Improvements to the Sabine-Neches Ship Channel Near Beaumont and Port Arthur, Texas" was published in the *Federal Register* (FR) on May 21, 2002 (67 FR 98:35801). Additionally, coordination with resource agencies was conducted through 11 meetings of the Interagency Coordination Team (ICT) and 30 technical working group meetings. More information about the ICT membership and activities is in Section 1.6. Detail about public outreach, meeting comments, and the ICT meetings and workshops can be found in Appendix A.

Existing water resource problems and needs in the study area were identified through coordination with Federal, State, and local agencies; area residents; waterway users; and the USACE and SNND. It should be noted that numerous concerns were raised during the public scoping meetings, letters received in response to those meetings, and a series of workshops with local public agencies and private organizations. The major issues and concerns identified through this process are discussed below. Summaries of the scoping meetings and copies of public comment letters are provided in Appendix A5. Some issues do not apply to the proposed CIP or are general concerns raised by the citizens of the area; these cannot be addressed in a project-specific FEIS. However, all of the concerns that are associated with the proposed CIP are addressed in this FEIS.

1.4.1 Navigation/Commerce

Waterway users are concerned that future increases in the Nation's dependence on imported oil and the SNWW's growing share of the import market will compound existing problems with transportation efficiency. The current 40-foot channel was completed in the late 1960s and, at that time, crude oil tankers averaging 40,000 DWT with loaded drafts of 36 feet were common. Vessels over 90,000 DWT are now used routinely for crude oil imports to both Beaumont and Port Arthur. Mother vessels in the 120,000 to 150,000 DWT range presently offload a partial load at the offshore lightering zone and then enter the SNWW along with the shuttle vessel. As imports have increased, the number of lightering vessels and product carriers has also increased, adding to shipping delays and congestion.

The existing narrow channel width creates congestion and transportation inefficiencies, resulting in potential problems with safety. Vessels are now wider due to new double-hull requirements and to industry changes to wider but shorter vessels. Wider vessels make meetings more difficult and, therefore, more dangerous. The SNWW is currently subject to transit rules, which are needed for the Sabine Pilots Association to safely guide large deep-draft tankers through the narrow channel. Increases in both inland barge and deep-draft vessel traffic along the waterway are expected to increase overall congestion and result in an increase in the likelihood of accidents. Historically, accidents on the SNWW are very low, due in large part to the existing pilot rules that minimize the probabilities of incidents involving deep-draft vessels. In 2006, two-thirds of the incidents involved shallow-draft tow transits. Overall, the ratio of incidents per transit was 1 percent or less for all transit types. Recently, installation of the Port Arthur vessel traffic service (VTS) is expected to reduce potential interactions between deep- and shallow-draft vessels.

It is believed that ship traffic through interior channel reaches contributes to existing shoreline erosion, and it is feared that a deeper channel will increase that erosion. Existing erosion is most severe along the Port Arthur and Sabine-Neches canals where the SNWW passes through a narrow, confined channel between Pleasure Island and Port Arthur. There is concern that a deeper channel would allow larger or more heavily laden vessels to use the waterway and cause additional erosion of channel shorelines.

The evaluation of alternatives other than a deeper navigation channel was urged in several comments. Suggestions included construction of a new port and pipeline terminal at the City of Sabine Pass. Others suggested that an offshore terminal similar to the Louisiana Offshore Oil Port (LOOP) be constructed. Both of these alternatives would avoid environmental impacts associated with channel improvements to the inland Port of Beaumont. It was also suggested that safety issues could be addressed by a vessel tracking and management system, rather than channel improvements.

1.4.2 Environmental

The primary environmental concern is the potential for the proposed CIP to increase saltwater intrusion and for higher salinity levels to further degrade marshes and cypress swamps in both Texas and Louisiana. The combined effects of subsidence and sea level rise (called relative sea level rise, or RSLR) are expected to increase the stress on existing marshes and worsen this trend. The public and resource agencies have identified severely stressed marsh areas at Texas Point and Salt Bayou in the Sabine Pass area, in the Neches River reach between Sabine Lake and Interstate Highway (IH) 10, and in the extensive marshes east of Sabine Lake. Marshes have been dying, due in large part to the combined effects of altered sediment delivery, saltwater intrusion, subsidence, and global sea level rise. Wetland loss results when sub-optimal salinities decrease biological productivity of marsh vegetation, leading to a decrease in organic matter accumulation, which, in turn, results in greater submergence because the rate of increase in marsh elevation cannot keep up with the rate of submergence due to RSLR (Day and Templet, 1989; Day et al., 1995; DeLaune et al., 1994; Nyman et al., 1993; Spalding and Hester, 2007). The death of wetland vegetation often results, followed by peat collapse, erosion, and wetland loss (DeLaune et al., 1994; Gough and Grace, 1999; Salinas et al., 1986; Visser et al., 1999; Webb and Mendelssohn, 1996). Cumulative effects of hydrologic alterations are also a concern, given that the existing project is believed to have contributed significantly to current wetland losses. Potential effects of increased salinities on cypress-tupelo swamps and bottomland hardwoods on the Neches and Sabine rivers at the upper margins of the study area have also been identified as significant potential impacts.

An associated issue is the deterioration of wildlife habitat and fishery nursery areas and the destruction of fish and wildlife resources that could occur as a result of increased wetland loss. Persistent emergent vegetation provides foraging, resting, and breeding habitat for a variety of coastal fish and wildlife species. Detritus from coastal marshes also provides a source of mineral and organic nourishment for organisms at the base of the food chain. The potential for proposed CIP impacts to oyster reef at Blue Buck Point at the mouth of Sabine Lake was also identified.

All or portions of the following federally and State-protected lands contain sensitive habitats that may be affected by the proposed CIP: the Sabine National Wildlife Refuge (NWR), the McFaddin NWR, the Texas Point NWR, the J.D. Murphree WMA, the Lower Neches WMA, the Tony Houseman WMA, and the Sabine Island WMA.

Potential impacts to threatened and endangered species are a concern, particularly dredging impacts to endangered sea turtles. The offshore channel deepening and extension will require the use of hopper dredges, which create particular hazards for sea turtles. Critical Habitat for the wintering piping plover is present in the study area.

Concern has been expressed that the proposed CIP could increase tidal amplitude and increase damage during storm surges by allowing the surge to inundate areas that have not been affected by previous storms. Potential for increased Gulf shoreline erosion is also a concern. In recent years, high shoreline erosion has caused substantial wetland losses on the Gulf shoreline from Texas Point westward to the vicinity of Sea Rim State Park.

The public has also expressed concern that dredging for the proposed CIP and the placement of dredged material will spread contaminated sediments or affect water quality. It is feared that new work dredging will release contaminants from past industrial discharges into the water column, or that areas selected for the beneficial use of dredged material could be polluted.

The beneficial use of dredged material to restore degraded marshes was encouraged by the public and resource agencies. The following sites were specifically identified as areas that could benefit: Rose City marsh, Bessie Heights marsh, Keith Lake marsh, marshes in the McFaddin NWR, east Sabine Lake marshes, and the Gulf shoreline at Texas Point and Holly Beach. Construction of a bird island in Sabine Lake was also suggested. The beneficial use of dredged material would reduce the need for new or expanded PAs and reduce potential wetland impacts.

The proposed CIP, including the Gulf ODMDSs, could impact Essential Fish Habitat (EFH) for red drum; brown, white, and pink shrimp; Spanish mackerel; and estuarine water column and mud/sand bottoms. Potential effects to nursery and foraging habitat for economically important marine fishery species such as spotted sea trout, flounder, Atlantic croaker, black drum, Gulf menhaden, striped mullet, and blue crab also need to be evaluated for adverse effects associated with proposed water control structures.

It was suggested that environmental impacts as a consequence of the proposed CIP should be avoided if possible. A lock at Sabine Pass, a sill or constriction at the mouth of Sabine Lake, and smaller water control structures in the marshes east of Sabine Lake were suggested as methods to minimize or avoid impacts. Conversely, other comments warned of the potential harmful effects of water control structures that inhibit the movement of marine organisms into and out of intertidal marshes.

1.4.3 Socioeconomic

The Ports of Port Arthur and Beaumont expressed concern over the socioeconomic effects of not improving the SNWW. Both are concerned that the SNWW is close to reaching its capacity for vessel traffic movement. It was urged that direct and indirect economic and social benefits of the SNWW be fully evaluated.

Considerable concern was expressed by government agencies in Louisiana that the proposed CIP would have adverse effects on their state's environment while providing no economic benefits for Louisiana. Officials at the West Calcasieu Port, Harbor, and Terminal District urged that navigation improvements be evaluated on a regionwide basis, because channel improvements in Texas could put their facilities and the Port of Lake Charles at a competitive disadvantage. Cameron Parish officials expressed support for economic development that would benefit their constituents. Cameron Parish officials were also concerned that lands suitable for commercial development at Sabine Pass were being considered for use as PAs. Developable lands are limited on the Louisiana side of the SNWW, and all are needed to promote economic development.

Jefferson County Drainage District #7 expressed concern that channel widening and deepening could affect the structural integrity of the Port Arthur Hurricane Protection Levee, pump stations, and closure structures. The Texas Department of Transportation (TxDOT) expressed concern that increased erosion could adversely affect State Highways (SH) 82 and 87. Both are located immediately adjacent to the SNWW and are affected by present channel bank erosion. Additional erosion of SH 87 could destroy the only road access to the City of Sabine Pass.

The high concentration of petrochemical refineries and terminals in the study area means that a large number of pipelines are also present. Local industries are concerned that these pipelines will be affected by the proposed channel deepening and that they will be responsible for the cost of moving these pipelines to accommodate the deeper channel.

Socioeconomic impacts on commercial fisheries are also a concern. A small, commercial shrimp fleet operating out of Sabine Pass could be adversely affected if the proposed CIP adversely affects EFH. There is also a concern that environmental impacts could adversely affect sport fishing, which is a popular activity throughout the study area.

Several members of the general public expressed concern that the cost of this project will be large, that benefits will not be sufficient to outweigh costs, and that costs will be passed on to taxpayers in the form of higher taxes.

1.4.4 Historic Properties

There is concern that use of PA 5 will adversely affect public access to the Sabine Lighthouse, a National Register property. A road around the perimeter of the PA is currently the only access route to the Lighthouse. Changes or enlargements to this PA could limit or remove access to this historic property.

Concern has also been expressed about the potential for proposed CIP improvements to affect the Sabine Pass Battleground Park, Fort Griffin, and associated shipwrecks. These sites and shipwrecks are associated with important battles during the U.S. Civil War.

1.5 PLANNING OBJECTIVES

The planning objectives of the proposed CIP include improvement in the efficiency of the deep-draft navigation system and maintaining the ecological values of the area's coastal and estuarine resources. Economic efficiency would result from the passage of more fully loaded ships, a reduction in the need for lightering and lightening, and a decrease in vessel delays. Protection of the area's coastal and estuarine resources would result from the beneficial use of dredged material and full compensation for unavoidable environmental effects.

1.6 INTERAGENCY COORDINATION TEAM

An ICT comprising the Federal and State resource agency representatives from Louisiana and Texas was established at the beginning of the study to advise the USACE on matters related specifically to the environmental impact review. ICT agencies and representatives are listed in Table 1.6-1. Agencies were asked to designate one official member who was authorized to speak for the agency and make decisions in the group format. Representatives from other local and State agencies or governments also participated in the ICT in an advisory capacity: Jefferson and Orange counties, Texas; Cameron and Calcasieu parishes, Louisiana. The USACE ICT members ensured that decisions were made within the framework of the USACE planning process and in compliance with Federal law and policy, including guidance such as Planning in a Collaborative Environment (Engineer Circular [EC] 1105-2-409) and the Environmental Principles (Engineer Regulation [ER] 200-1-5). Insofar as was possible, given the USACE planning, policy, and schedule constraints, important decisions related to identifying and studying potential ecological impacts, and identifying alternatives for compensatory mitigation were made by consensus within the ICT. Toward the end of the planning study, remodeling and reanalysis were conducted by the USACE to incorporate the effects of a revised plan of navigation improvements, the projected future rate of RSLR, and future freshwater inflows. Because of schedule constraints, this modeling was performed without ICT consultation. However, the results of this reanalysis were coordinated with the ICT, and no changes in the recommended ecological mitigation plan resulted from the remodeling and reanalysis.

Technical work addressing specific environmental concerns or planning objectives was done by several smaller workgroups whose members were taken from the ICT. Each of these workgroups and its purpose is discussed separately below.

- The Restoration and Beneficial Uses Workgroup (RW) was created to develop ideas for ecosystem restoration and the beneficial use of dredged material in the study area. Although ecosystem restoration is not a study purpose, ideas for potential restoration projects were explored by this workgroup. The RW also reviewed suggestions provided during the public workshops for this purpose (Gulf Engineers and Consultants, Inc. [GEC], 2002).

Table 1.6-1
SNWW ICT and Workgroup Participants

U.S. Army Corps of Engineers
Carolyn Murphy
Janelle Stokes
Paula Wise
Robert Hauch
Gloria Appell
John Baker
John Otis
Nancy Young
John Damm
Jackie Lockhart
Ed Reindl
Baldev Mann
Seth Jones
Kristy Morten
Frank Garcia
Richard Tomlinson
Lizette Richardson
Volker Schmidt
Gary Brown, ERDC
Steve Maynord, ERDC
Nana Parchure, ERDC
Mark Gravens, ERDC
Rao Vemulakonda, ERDC
Robert McAdory, ERDC

Sabine Neches Navigation District
Tom Jackson
Randall Reese
Clayton Henderson

U.S. Environmental Protection Agency
Mike Jansky
Barbara Keeler
Jim Herrington
Renee Ballew
Kenneth Teague
Phillip Crocker

Texas General Land Office
Dennis Rocha
Tammy Brooks
Juan Moya

Texas Parks and Wildlife Department
Woody Woodrow
Jamie Schubert
Jim Sutherlin
Mike Rezsutek
Terry Stelly
Jerry Mambretti
Jim Tolan
Nathan Kuhn

Texas Water Development Board
Barney Austin
Junji Matsumoto

Texas Commission on Environmental Quality
Robert Hansen

Texas Department of Transportation
Raul Cantu

Sabine River Authority of Texas
Jack Tatum
Gerard Sala
John Payne

Louisiana Department of Natural Resources
Gerry Duszynski
Kirk Rhinehart
Kyle Balkum
Dan Llewellyn
Steven Gammill

Louisiana Department of Environmental Quality
David Daigle

Table 1.6-1, cont'd

U.S. Fish and Wildlife Service	**Louisiana Department of Wildlife and Fisheries**
Phil Glass	Fred Dunham
Darryl Clark	Kyle Balkum
Andy Loranger	Michael Harbison
Dean Bossert	
Pat Walther	**PBS&J**
Chris Pease	Martin Arhelger
Steve Reagan	Dave Buzan
Roy Walter	Kathy Calnan
Brian Cain	Andy Labay
Donna Anderson	Eric Monshaugen
	Tony Risko
U.S. Natural Resource Conservation Service	Lisa Vitale
Eddie Seidensticker	
	Turner Collie & Braden
National Marine Fisheries Service	Georganna Collins
Rusty Swafford	Carrie Eick
Richard Hartman	

- The Hydrodynamic and Salinity Modeling Workgroup (MW) provided data to assist the hydrodynamic salinity (HS) modeling and verification process and reviewed modeling results as part of the impacts evaluation. The modeling was conducted by the USACE's Engineer Research and Development Center (ERDC), reported in Brown and Stokes (2009).

- The Contaminants Workgroup (CW) evaluated water and sediment quality associated with the proposed CIP, including characterization of existing conditions in the project area and the results of physical and chemical analyses conducted. This evaluation is reported in PBS&J (2004a, 2004b).

- The ODMDS Workgroup (OW) was created to advise in the preparation of the Site Designation FEIS for the proposed ODMDSs. The OW reviewed existing data, recommended additional studies, reviewed the results of physical, chemical, and biological analyses, and reviewed the ODMDS FEIS, which is attached to this FEIS as Appendix B.

- The Habitat Evaluation Workgroup (HW) reviewed and classified existing habitat, performed field evaluations to document existing conditions, and developed and applied procedures for the prediction of without and with-project conditions using the Wetlands Value Assessment (WVA) ecological model. The HW also reviewed results of the ecological modeling and report, which is provided as Appendix C to the FEIS.

1.7 RESOURCE MANAGEMENT OPPORTUNITIES

Dredged material is now viewed as a regionally significant resource that can be put to positive use, rather than a waste by-product of channel improvements. The principles of Regional Sediment Management

(RSM) were applied to ensure that the dredged material arising from the SNWW CIP would be viewed as valuable resource, integral to economic viability and environmental sustainability of the region (Martin, 2002). In developing the DMMP for the project, this study searched for opportunities to achieve savings by coordinating projects, identified opportunities for beneficial use, and sought ways to contribute to coastal watershed goals related to sediment management. The large quantities of dredged material that would be generated by the proposed CIP created an ideal opportunity for the exploration of the beneficial use of dredged material. A series of public workshops and extensive ICT consultation evaluated a wide array of opportunities to use dredged material beneficially (GEC, 2002; Turner Collie & Braden, 2003). Potential uses of dredged material that were evaluated for this study included estuarine hydrologic and habitat restoration and ways to keep sediment in the system such as Gulf shoreline nourishment and offshore feeder berms. A complete description of alternatives for regional sediment management of the SNWW CIP dredged material is provided in Chapter 2.

2.0 ALTERNATIVES

This chapter is divided into five sections. The first discusses the history and process used in formulating alternatives that address planning objectives. Section 2.2 presents the preliminary screening of nonstructural and structural alternatives; the comparison of detailed structural alternatives follows in Section 2.3. Section 2.4 summarizes the results of the detailed screening and provides a full description of the Preferred Alternative. Section 2.5 describes and evaluates alternatives for the management of dredged material arising from construction and maintenance of the Preferred Alternative, and the incremental impacts and benefits of the DMMP. Placement features include beneficial use features, upland placement areas, and ODMDSs.

2.1 HISTORY AND PROCESS FOR FORMULATING ALTERNATIVES

The FFR, to which this FEIS is attached, provides a detailed description of the analysis of alternatives; however, a summary of this process is provided below. In this analysis, different ways of addressing identified problems, needs, and concerns were systematically evaluated while considering environmental factors. A three-phased screening process was used to identify the Preferred Alternative: 1) preliminary alternatives screening; 2) second screening; and 3) detailed evaluation of final alternatives. During preliminary screening, the expected “No-Action” Alternative was developed for comparison with other alternatives. This alternative was carried through the subsequent planning phases for comparison to other alternatives. Nonstructural and structural alternatives that could address planning objectives were also developed. The nonstructural alternatives evaluated the use of a VTS to alleviate transportation efficiency and safety concerns, the relaxation of existing pilot rules, and an alternative mode of commodity transport. For the structural alternatives, a wide array of structural channel improvements was evaluated. Over 120 different combinations of various depths and widths were analyzed during the preliminary screening. In the second phase, a more detailed evaluation of screened alternatives was performed. The final channel widths were determined during the second screening. With the exception of selective widening or bend easing in a few areas, no changes were made to the existing width of inshore navigation channels; the width of most of the offshore navigation channels and proposed extension were reduced from the existing width of 800 to 700 feet. Six channel depths (45, 46, 47, 48, 49, and 50 feet) with the set channel widths and from three to eight potential turning/anchorage basins on the Neches River Channel (Figure 2.1-1) were selected for the final detailed analysis. In accordance with the USACE Actions for Change initiative (USACE, 2006a), potential risks and uncertainties related to engineering, economic, and environmental analysis were evaluated throughout the alternatives analysis. Descriptions of these risks are discussed in the FEIS topic areas to which they relate, and they are also summarized in the FFR.

An economic evaluation of various deepening and widening alternatives was conducted to identify alternatives that maximized National Economic Development (NED) benefits. This evaluation is presented in detail in the FFR; only a brief summary is provided here. Project benefits were based on reductions in transportation costs generated from more-efficient vessel loading and from reductions in vessel delays. Benefits and costs were calculated for Port Arthur and Beaumont depth alternatives of 43, 45, 47, 48, 50, 52, and 55 feet, and for other separable elements of the proposed CIP. The initial selection of the widening alternatives to be evaluated was based upon the results of a vessel simulation model conducted by the ERDC with input from the Sabine Pilots Association. The alternatives were subsequently screened based upon comparison of associated vessel delay costs and the initial construction cost estimates. Channel widening and turning anchorage basin benefits for deep-draft traffic were also evaluated by estimating benefits from delay reductions using an economic traffic model developed by the ERDC. Ecological mitigation costs for the six depth alternatives were interpolated based upon changes in salinity. The detailed evaluation of final alternatives concluded with the selection of a Preferred Alternative. Detailed evaluations of alternatives for the management of dredged material and the mitigation of ecological impacts were then performed for the Preferred Alternative. This evaluation concluded with the development of a DMMP and an ecological mitigation plan. The DMMP includes measures in which dredged material is used to restore wetland habitat, avoiding and offsetting impacts of the Preferred Alternative. The evaluation of alternatives for the management of dredged material and the recommended placement plan are described later in this chapter. The evaluation of mitigation alternatives that compensate for remaining unavoidable impacts to significant habitats and resources, and the recommended mitigation plan are described in Chapter 5 of this FEIS. Least-cost analyses of dredged material placement and an incremental cost analysis of mitigation alternatives were conducted to select recommended placement and mitigation measures; these analyses are presented in the FFR.

2.2 PRELIMINARY AND SECOND SCREENING

2.2.1 No-Action Alternative

The No-Action Alternative forms the basis against which all other alternative plans are measured. Under the No-Action Alternative, the Federal Government and the non-Federal sponsor would not implement the proposed CIP and the objectives of improving the navigational efficiency of the waterway would not be met.

It is expected that imports of crude oil and petroleum products would continue to expand to keep pace with the predicted national need for these products and the projected continuing declines in U.S. production. Vessel trips would increase to accommodate the higher imports, and higher costs associated with the current lightering and vessel movement limitations would continue. Increased vessel trips would exacerbate the existing channel bank erosion caused by vessel wakes in the confined channel reaches of the SNWW. It is projected that the existing trend in wetland losses would accelerate due to RSLR and altered hydrology and salinity levels caused by the existing SNWW navigation channels, the GIWW, and canals, levees, and water control structures associated with oil and gas exploration and production, logging, fishing, and hunting lands.

The No-Action Alternative would retain the 40-foot SNWW navigation channel with no improvements. The current channel dimensions do not allow the existing fleet to use the channel efficiently. Ships are limited by the current channel depth and width and safety limitations that result in one-way and daylight-

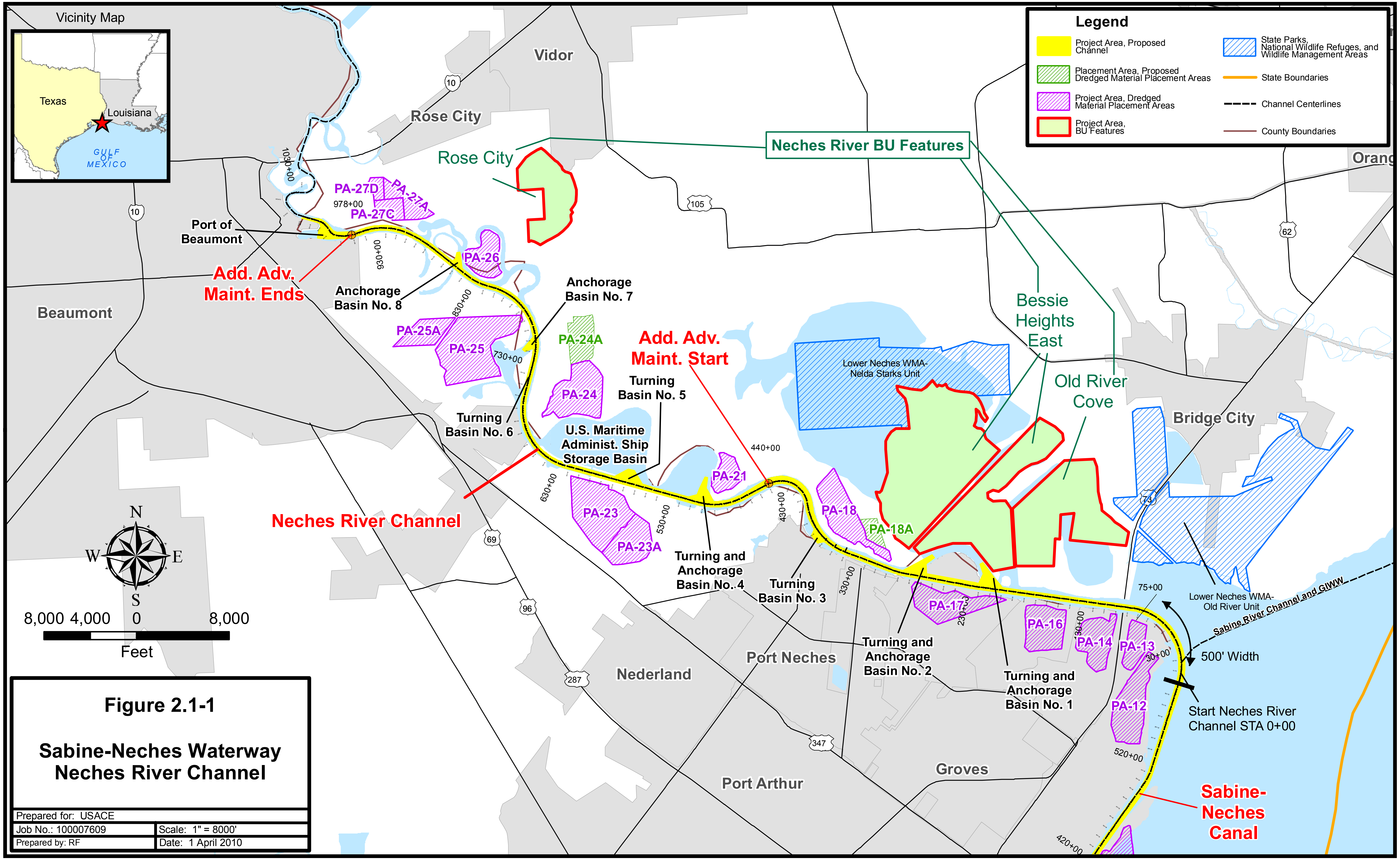

Figure 2.1-1

Sabine-Neches Waterway Neches River Channel

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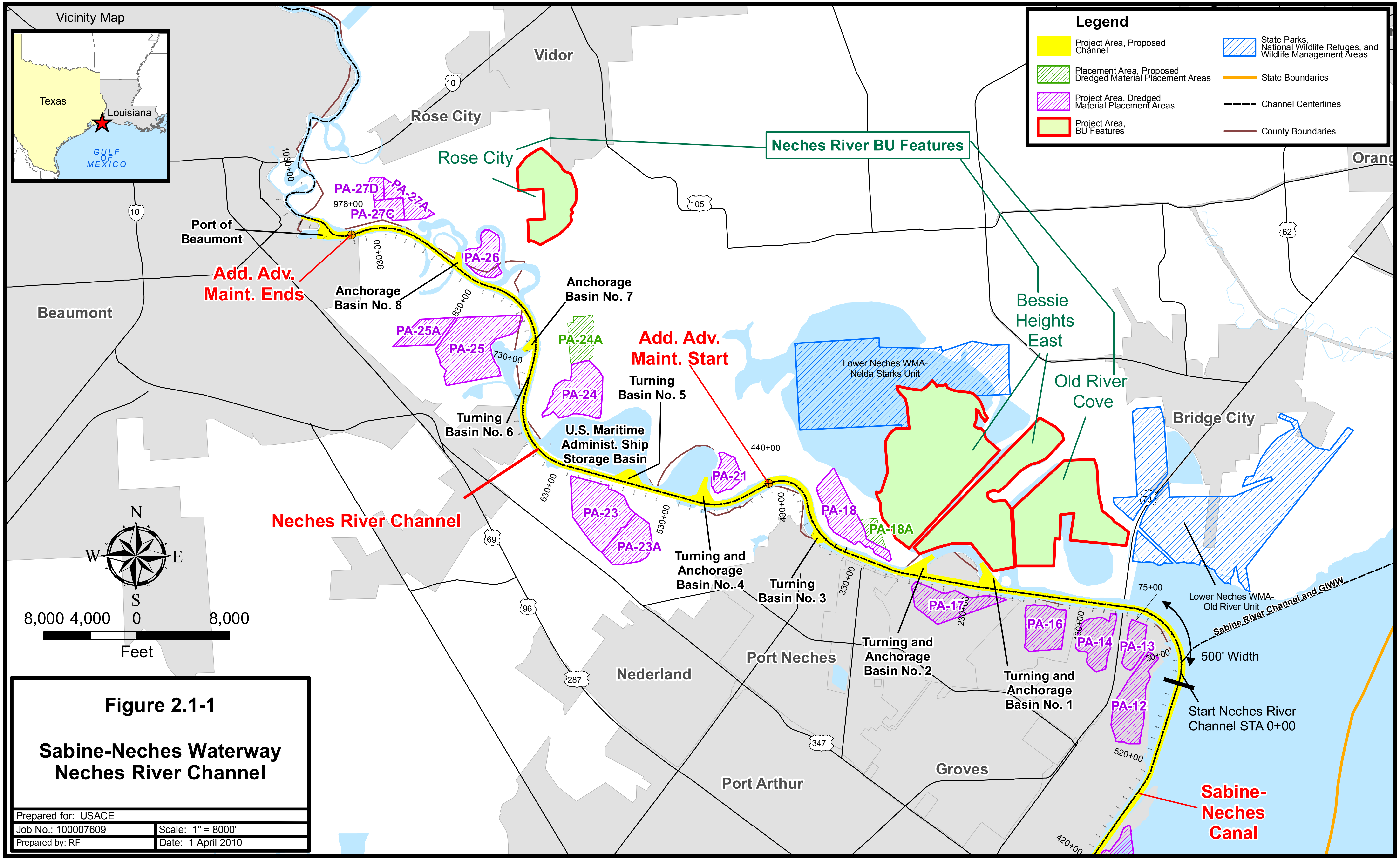

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only sailing restrictions. The need to lighter products and/or light load vessels increases overall vessel trips and shipping costs, and decreases the efficiency of the vessels using the waterway. The waterway is often congested because of frequent movements of lightered vessels carrying petroleum products from the Gulf to refineries on the Neches River Channel, and because of barge through-traffic using the GIWW. Vessels are now wider, placing limitations on the combined beam widths and drafts for vessel meetings on the waterway. Historically, casualty incidents on the SNWW channel are very low, due in large part to existing pilot rules that minimize the probability of incidents involving deep-draft vessels. Existing and proposed LNG facilities on the Sabine Pass Channel and Port Arthur Canal are subject to strict USCG regulations and to local pilot rules that prevent LNG vessels from meeting other vessel traffic. Increases in both inland barge and deep-draft vessel traffic along the waterway are expected to increase overall congestion and the likelihood of accidents. However, since the overall rate of casualty incidents is very low, the number of additional accidents in the future would also be low.

The No-Action Alternative would continue disposal activities for maintenance material from the 40-foot project in conformance with most, but not all, existing practices. In the FFR, the DMMP for the No-Action Alternative (the future without-project [FWOP] condition) is referred to as the Base Plan. The Base Plan forecasts disposal facility needs for all material that would be generated by maintenance dredging of the existing 40-foot project over a 50-year period of analysis. The 50-year analysis determined that additional capacity in upland PAs would be required, and it identified a least-cost beneficial use (BU) feature (the Gulf Shore BU Feature) that should be adopted as part of the Base Plan. The Gulf Shore BU Feature has also been included in the DMMP for the Preferred Alternative; it will be treated as a general navigation operation and maintenance (O&M) component.

No differences from existing offshore placement activities were identified for the Base Plan. The offshore channels (Sabine Bank Channel, Sabine Pass Outer Bar, and Sabine Pass Jetty Channel) would be maintained with a hopper dredge, and approximately 162 million cubic yards (mcy) of material would be placed in the four existing ODMDSs (sites 1–4). Bed sediments in the offshore channels vary from 4.3 percent sand and 95.7 percent silt plus clay in the Sabine Pass Outer Bar Channel to 24.3 percent sand and 75.7 percent silt plus clay in the Sabine Bank Channel (Parchure et al., 2005). These sites have sufficient capacity for the 50-year period of analysis as they are located in a dispersive environment where dredged material does not accumulate.

For the inshore Sabine Pass Channel, a cost analysis of placement alternatives in the FFR resulted in a change from traditional upland placement practices involving PA 5. Rather than placing all of the maintenance material from this channel into upland PA 5, the potential beneficial use of material from the channel section closest to the coast (Section 5) was evaluated to determine whether it could be used to nourish the Gulf shoreline on both sides of Sabine Pass (Gulf Shore BU Feature). Material from Section 6 of the Sabine Pass Channel would continue to be placed into PA 5 because the longer pumping distance to the coast makes shore nourishment cost prohibitive. The cost analysis determined that the Gulf Shore BU Feature is more cost effective than placing the material in the upland PA 5, and therefore it was adopted as part of the Base Plan.

Under the Base Plan, all of the inshore channels of the existing project (Sabine Pass Channel, Port Arthur Canal, Sabine-Neches Canal, and the Neches River Channel) would continue to be maintained by hydraulic pipeline dredge. Material from non-Federal dredging of private mooring and dock facilities would also continue to be placed in upland PAs along with the material from the Federal project. Existing management practices that utilize 16 upland PAs located adjacent to the channel from Sabine Pass to the Beaumont Turning Basin would continue. To contain 229.4 mcy of material over the 50-year period of analysis, the heights of existing PAs would be raised on a regular, recurring schedule in accordance with existing SNWW management practices. One new PA in the middle reach of the Neches River Channel (an expansion cell at PA 24A) would be needed to provide sufficient capacity for the period of analysis. On average, bed sediments vary in the inland channels from 38.3 percent sand and 61.7 percent silt plus clay in the Neches River Channel to 16.2 percent sand and 83.8 percent silt plus clay in the Port Arthur Canal (Parchure et al., 2005). Beneficial use features are not included in the Base Plan for the inland channels because the lack of suitable material makes construction and maintenance of containment levees more expensive than placing the material in existing PAs. However, Section 204 projects would be considered on a project-by-project basis if non-Federal sponsors express an interest in paying the incremental cost for such projects.

2.2.2 Nonstructural Alternatives

2.2.2.1 Vessel Traffic Service

The existing VTS along the SNWW was evaluated as a nonstructural alternative. Although this service is managed by the USCG and thus is not within the jurisdiction of the USACE, it was evaluated because it appeared to be a potential alternative to structural plans. VTS was authorized by certain sections of the Port and Waterways Safety Act of 1972; the Oil Pollution Act of 1990 made participation mandatory in areas serviced by existing and future VTS (USCG, 2008a). The purpose of VTS is to provide active monitoring and navigational advice for vessels in particularly confined and busy waterways. VTS is designed to expedite ship movements, increase transportation system efficiency, improve all-weather operating capability, and enhance vessel safety and marine environmental protection (SETWAC, 2007; USCG, 2008b).

The Vessel Traffic Center in Port Arthur became operational in 2005 and monitors every ship, vessel, or boat that attempts to enter or leave the SNWW and the GIWW in the Port Arthur service area. Infrared cameras, along with radar, radio-telephone reports from vessel operators, and satellite surveillance sensors on towers along the SNWW allow VTS controllers to zoom-in on vessel activity at a moment's notice. The satellite-based Automatic Identification System (AIS), required by the Maritime Transportation Security Act of 2002, assists the VTS by determining exactly what a specific commercial vessel is carrying, along with its speed, dimensions, and destination. Most commercial vessels using the waterway were required to have AIS equipment installed by the end of 2004 (Jackson, 2004). These include power-driven vessels 66 feet in length or longer; power-driven vessels of 100 gross tons or more carrying one or more passengers for hire; towing vessels 26 feet or longer while navigating all dredges and floating plant likely to restrict or affect the navigation of other vessels; and all vessels required to participate in the Vessel Movement Reporting System. However, not all vessels are required to carry AIS; in particular, pleasure crafts, fishing boats, and warships are exempt.

Currently, VTS Port Arthur is a voluntary system operated in accordance with existing VTS regulations. Until rules regarding VTS Port Arthur are published, vessels are exempt from all VTS and Vessel Movement Reporting System requirements, except the requirement for AIS continuous broadcasts. When VTS Port Arthur is included in the VTS regulation, participation will become mandatory. At that time, VTS Port Arthur will be authorized to designate temporary reporting points and procedures, impose vessel-operating requirements, or establish vessel traffic routing schemes. During conditions of vessel congestion, restricted visibility, adverse weather, or other hazardous circumstances, VTS may control or manage traffic by specifying times of entry, movement, or departure to, from, or within a VTS area.

While the VTS will help congestion and improve safety to some degree, the USCG's traffic management role is limited to specific circumstances when the SNWW is congested or experiencing hazardous conditions. The VTS assists vessel operators in making independent decisions regarding the safe navigation of their vessels, for which they retain complete responsibility. In this sense, VTS should be considered primarily a navigational aid, a tool for mariners to use along with numerous other tools to facilitate safe navigation (USCG, 2008b).

2.2.2.2 Relaxation of Existing Pilot Rules

The SNWW is currently subject to transit rules that are needed for the pilots to safely guide large tankers through the narrow channel. These transit rules or restrictions are agreed upon by the shipping industry, supported by the USCG Captain of the Port Orders under the Ports and Waterways Safety Act of 1978, as amended, and administered by the Sabine Pilots Association (2007). An agreement enforcing these rules, dated January 12, 1981, will remain in force until the Sabine shipping industries, Sabine Pilots Association, and USCG agree to its revision or modification.

The existing 700-foot-wide offshore reach of the SNWW channel does not have vessel-meeting restrictions; however, in the narrower channel reaches, vessel-meeting restrictions are currently imposed. A general overview of the transit rules are:

- Daylight only sailing restrictions applied in specific reaches for vessels that exceed certain DWT, length, and breadth criteria.
- No meeting during nighttime sailing for vessels exceeding a given draft limitation.
- No meeting during either day or night, applied to vessels by DWT, length, breadth, and draft combinations.

Relaxation of the existing pilot rules for the waterway was considered as a nonstructural alternative early in the planning process. However, due to concerns about vessel handling and associated safety and that vessels utilizing the waterway are wider than those using the channel even 5 to 10 years ago, the Sabine Pilots Association would not consider relaxing the rules. The expectation for the with- and without-project future is that pilot rules will continue to limit the possibility of vessel meetings in the Sabine-

Neches Canal reach and that both vessel and shallow-draft tow movements will be scheduled through both VTS and communication between vessel pilots.

While vessel traffic is expected to increase under both the No-Action and future with-project (FWP) conditions, increases with a deeper channel are projected to be slightly lower because channel improvements will allow more deep-draft cargo to be carried with fewer vessel trips. Associated reductions in deep-draft vessel traffic would thereby serve to reduce the probability of casualties. However, since casualty occurrences in the SNWW are rare, the proposed improvements would not have a discernible effect on casualty rates. For LNG vessels, USCG safety rules will be the same with or without a deepened channel.

2.2.2.3 Alternative Mode of Commodity Transport

Offshore oil terminals were evaluated as an alternative mode to landside port delivery of crude petroleum. Three offshore terminal alternatives were considered in the analysis, one existing and two proposed. The decision to use an offshore terminal instead of lightering or constructing a deeper channel is complicated but largely depends on the relative cost per ton, relative market volumes, and facility accessibility. While a quantitative analysis of a LOOP alternative is beyond the scope of USACE planning study, the overall infrastructure requirements were examined to the extent possible. Pipeline capacities and necessary expansions were identified, and the reasons for current and past choices were evaluated as were expectations about future interest.

The existing offshore terminal, the LOOP, is America's first and only deepwater port. LOOP is presently operating at capacity and has been since 2005. In addition to new customers brought on due to infrastructure damages associated with the 2005 hurricanes, recent increase in the LOOP is tied to utilization associated with domestic production in the U.S. Gulf. Present use of LOOP consists of Louisiana-based refineries and U.S. Gulf Coast state domestic offshore production interests. LOOP's existing base of customers use it as one of several options for delivering crude oil to their Gulf Coast refineries. Access to LOOP for the SNWW market would require substantial investment as SNWW crude oil import volume nearly equals LOOP's capacity. LOOP's design capacity of 1.4 to 1.8 million barrels per day is only marginally higher than SNWW 2003 to 2005 crude petroleum import volume, which ranged from 1.1 to 1.3 million barrels per day (USACE, 2007a). The investment necessary for LOOP to process SNWW's entire crude petroleum throughput would require a doubling of capacity.

While all of SNWW's crude oil could not currently transfer to LOOP, some tonnage could be diverted. The SNWW users continue to consider LOOP along with other alternatives; however, continued practices suggest that LOOP is not a cost-effective alternative to the existing SNWW practice of its land-based ports. The volume of potential diversions depends upon various ranges of LOOP expansion or construction of a new facility. The large fixed cost of expansion, and associated financing costs, necessitate participation by a consortium of companies. The SNWW industries have not found the option of investing in LOOP, and the necessary associated infrastructure expansions, to be a cost-effective alternative to existing practices of either direct shipment or offshore lightering. The lack of incentive has remained since the 1970s. An additional variable pertinent to the current evaluation is that LOOP would appear to be a less attractive cost option when compared to lower shipping costs that the SNWW improvement project is expected to provide.

LOOP is located offshore of Grande Isle, Louisiana, in 110 feet of water. Grande Isle is 302 miles east of Port Arthur and Beaumont. LOOP was organized in 1972 as a Delaware corporation and converted to a limited liability company in 1996. Marathon Ashland Pipe Line LLC, Murphy Oil Corporation, and Shell Oil Company are LOOP's owners. LOOP is the only port in the U.S. capable of offloading deep-draft tankers known as Ultra Large Crude Carriers (ULCC) and Very Large Crude Carriers (VLCC). Along with offloading crude from VLCCs, LOOP also offloads smaller tankers. LOOP consists of three single-point mooring buoys used for the offloading of crude tankers and a marine terminal consisting of a two-level pumping platform and a three-level control platform.

A 48-inch-diameter pipeline connects the LOOP Marine Terminal located 23 miles offshore in the Gulf to the Clovelly, Louisiana, storage facilities. Clovelly is approximately 260 miles east of the SNWW Port Arthur and Beaumont facilities. Four pipelines connect the onshore storage facility to refineries in Louisiana and along the Gulf Coast. The Clovelly facility provides interim storage for crude oil before it is delivered via connecting pipelines to refineries on the Gulf Coast and in the Midwest. The oil is stored in eight underground caverns leached out of a naturally occurring salt dome. In 1996, one cavern was dedicated to the production streams coming in from the deepwater Gulf.

The domestic offshore crude oil system uses the same distribution system used by the foreign barrels. The caverns are capable of storing approximately 50 million barrels of crude oil (a barrel of oil is equal to 42 U.S. gallons). In addition, LOOP has an aboveground tank farm consisting of six 600,000-barrel tanks. LOOP operates the 53-mile, 48-inch LOCAP pipeline that connects LOOP to CAPLINE (Amoco Cushing-Chicago Pipeline Company) at St. James, Louisiana. CAPLINE is a 40-inch pipeline that transports crude oil to several Midwest refineries. St. James is 227 miles east of Port Arthur and Beaumont. LOOP is connected to over 50 percent of the U.S. refinery capacity and has offloaded over 7 billion barrels of foreign crude oil since its inception.

LOOP is designed to handle 1.4 million barrels per day, but depending on the sizes of ships being serviced, it can handle 1.8 million barrels per day. The variance relates to the pumping rates of the tankers using the facility. Larger tankers tend to have faster pumping rates, with some capable of pumping 80,000 barrels per hour. Smaller tankers may only be able to pump 35,000 barrels per hour. When fully operational, LOOP is generally the largest point of entry for crude oil imports into the U.S. About 13 percent of all waterborne foreign imports pass through LOOP each day. Again, LOOP's design capacity of 1.4 to 1.8 million barrels per day is only marginally higher than the SNWW 2003 to 2005 crude petroleum import volume, which ranged from 1.2 to 1.4 million barrels per day. Of the SNWW's approximate 1.3 million barrels per day import volume, terminals on the SNWW transport approximately 400,000 barrels per day of waterborne crude oil via pipelines to inland refineries including refineries in Texas, Louisiana, Oklahoma, Ohio, Arkansas, and Kentucky (Martin Associates, 2006). In total, the SNWW delivers approximately 12 to 16 percent of the crude oil supplied to domestic refineries east of the Rockies. Refineries supplied via the SNWW provide transportation fuels and other products to consumers along the Gulf Coast, East Coast, and in the Midwest regions. The SNWW ports presently receive about 1 percent of their daily input through LOOP. Additional offshore and landside infrastructure would be necessary for an increase in volume to take place.

Although there are some competing markets, the SNWW and LOOP generally serve parallel markets, with LOOP consistently processing very large volumes and SNWW serving relatively smaller parcels. The sizes of the VLCCs using LOOP typically exceed 300,000 DWT, whereas the maximum-sized vessels using the SNWW are 175,000 DWT. The maximum design draft of these vessels is 55 feet or less. The minimum-sized crude oil tankers using the SNWW are in the 70,000 to 80,000 DWT range and have design drafts between 40 and 48 feet. LOOP's foreign petroleum imports are from the Middle East, whereas the SNWW's market consists of direct shipments from Mexico and Venezuela and lightened mother vessels and shuttles. It has been noted that the cost effectiveness of LOOP lessens for small vessel sizes. The SNWW has the ability to serve a more general market and range of users. In discussions with local port and oil industry personnel, it is noted that LOOP and similar proposals serve crude petroleum but do not serve a full range of petroleum and bulk cargoes that use the SNWW.

The most-immediate obstacle to increased use of LOOP or a new offshore facility is lack of major limitations for direct connection from LOOP to SNWW. A marginal increase in the SNWW's use of LOOP from its present 1 percent share would require LOOP pipeline connection modifications involving multiple pipelines and multiple companies. Such an investment may generate the necessity for higher throughput charges, which, in turn, may make access less cost effective than in the past. An industry analyst noted that, to a large extent, the companies demand that each segment, including pipeline transportation, stand on its own economically (Rabinow, 2004). The long-term availability of LOOP since the 1970s and low participation by the SNWW companies indicate that LOOP and new offshore terminal proposals have not provided the market utilization incentives for significant shares of the SNWW crude oil to shift towards these alternatives. The long-term trend is for domestic refining capacity to become more concentrated in regional centers and for imports of petroleum products to grow. This trend is evident with the SNWW with crude oil import tonnage exceeding that of any other U.S. port and being equal to LOOP. Imports of refined products and partially refined crude oil have grown significantly as have the use of draft-constrained vessels for transporting these cargoes.

In 2001, construction of a new terminal (called the Bulk Oil Offshore Transfer System, or BOOTS) offshore of Sabine Pass, Texas, was proposed. The relatively long distance from LOOP to the SNWW and the need for additional infrastructure suggest that a facility closer to the SNWW would be an attractive alternative to LOOP for SNWW channel improvements. However, the BOOTS facility has not yet been constructed, and the regulatory permit application is inactive. The USCG has had no update on the proposal and does not expect a submittal. At the present time, the potential user of the proposed project is the terminal proponent. They noted that their participation as sole supporter is not feasible financially. It was specifically noted that their feedstock needs were not sufficient to finance the expansions to LOOP.

The BOOTs project proponent was contacted, and it was found that a new location farther down the Texas coast near Freeport is presently being considered. Access by the SNWW refineries to the proposed Texas Offshore Ports System (TOPS) would have advantages over LOOP. There is an existing pipeline from Freeport to Texas City; however, its connection to Port Arthur would necessitate a new pipeline from Texas City to SNWW, a distance of approximately 75 miles. Industry indications are that the use of an offshore Freeport terminal would not serve as the exclusive supplier, just as LOOP is not the exclusive supplier for the Louisiana markets. TOPS would reduce the vessel traffic on the Neches River by reducing the number of shuttle vessels coming into the SNWW from the offshore lightering zone. However, a disagreement among the partners recently led to the withdrawal of two of the three companies from the partnership.

In a general discussion with industry, a representative noted that offshore oil terminal projects surface periodically, but the cost of these alternatives keeps them from moving beyond the initial planning stage. It is noted that the attractiveness of offshore alternatives over existing use of the SNWW is diminished by its ability to only serve one commodity (i.e., crude petroleum). It was added that the various crude oil blends and grades of oil introduce a range of additional concerns that add to throughput costs. The pipelines and associated infrastructure requirements vary between potential users, and mingling of products and grades of crude is complex and difficult to facilitate. The construction of an offshore terminal that can meet the needs of various users is a challenge with the costs to realize multiparty usage creating an impasse to these proposals moving beyond the initial planning stage. Recognition of the cost of multiple pipelines necessary to meet the needs of the large base of customers necessary to finance these project alternatives has resulted in a stalemate in the decision process.

Expansion of LOOP, construction of a new offshore facility such as BOOTS or TOPS, or an unloading terminal along the Sabine Pass or Port Arthur Canal reaches would reduce the vessel traffic on the Neches River. The reduction in ship traffic resulting from LOOP, BOOTs, or TOPS would reduce the economic viability of the SNWW deepening and widening project. However, past and present trends in infrastructure and fleet investments indicate that industry intends to continue using the Neches River Channel. An increase in the number of specially designed SNWW vessels was recently completed by one company, and another has invested in Neches River dock modifications for the larger “Aframax” and “Suezmaz” vessels. The focus of immediate private-sector petroleum vessel investments is concentrated on SNWW improvements rather than offshore or on the Sabine Pass Channel or Port Arthur Canal. Ongoing consultation with industry continues to show that commitments to offshore terminal investment have not materialized. During the 30 years since LOOP has become operational, several Texas Gulf Coast channel improvement projects have been completed and the benefits have been accrued. Offshore terminals would not accommodate products other than crude oil, and a significant proportion of benefits for the Neches River Channel project improvement are from refined petroleum products. The offshore terminal was found not to meet the efficiency objective for all waterway users as it addressed the needs of only one user and commodity (crude oil). For these reasons, this alternative was eliminated from further consideration.

2.2.3 Structural Alternatives

Six different channel depths (43, 45, 48, 50, 53, and 55 feet) were evaluated in combination with several different widening scenarios during preliminary and second alternatives screening. Widening the upper reaches of the SNWW to 500 feet through the Port of Beaumont was evaluated, as were selective widening alternatives of different widths for specific reaches. This analysis resulted in over 120 variations of alternative depths and widths. Costs were estimated for all of these variations and compared to benefits during this initial screening process. An incremental analysis of benefits for separable elements of the project was also conducted. Preliminary analysis indicated that approximately 65 percent of the project benefits were associated with the upstream Beaumont area and 35 percent with the Port Arthur area; therefore, continuing improvements up the Neches River to Beaumont was economically justified. The initial screening determined that depths of 45 feet and greater had higher net excess benefits than depths less than 45 feet. The initial analysis also showed slightly higher net excess benefits for the 52-foot and 55-foot depths than for depths between 45 and 50 feet. However, because the rate of change in net excess benefits for depths over 50 feet was relatively small, and due to the non-Federal sponsor's budget constraints, only depths between 45 and 50 feet were advanced for final screening. Ecological benefits and mitigation costs were not calculated for the 120 plus variations during the preliminary and second screening. However, the array of structural improvements was assessed for potential effects to the environment in a nonquantitative manner.

Deepening and widening combinations that were evaluated during preliminary screening are listed below.

- Maintain existing 40-foot depth with 500-foot width, and 3 existing turning basins, to Port of Beaumont;

- Deepen the entire waterway from the Gulf to the Port of Beaumont at depths of 43, 45, 48, 50, 53, and 55 feet with an extension of the Entrance Channel ranging from 5 to 25 miles in length and no widening;

- Deepen the entire waterway, considering the various depths (43, 45, 48, 50, 53, and 55) with an extension of the Entrance Channel ranging from 5 to 25 miles in length, and widen the Sabine-Neches Canal to Beaumont to match the 500-foot-wide channels in the lower reach;

- Deepening but not widening of the Taylor Bayou Channels and Basins at the various depths (43, 45, 48, 50, 53, and 55).

Two of the preliminary structural alternatives were found to be infeasible due to technical, economic, and environmental constraints, and were therefore not advanced into the second screening:

- Widening the entire existing channel from Sabine Pass to the Port of Beaumont, at widths varying from 500 to 700 feet, was found to be infeasible because a widening-only alternative would not provide the additional draft needed to increase navigation efficiency for the largest number of waterway users. In addition, this alternative would have had significant ancillary effects such as the destruction of large amounts of emergent land and wetlands, the disruption or displacement of a large number of existing docks and berthing facilities, the relocation of bridge supports for existing highway bridges, and the creation of many new PAs.

- Selective widening only (widening only certain reaches of the channel) was eliminated because it would provide even fewer navigation benefits than the widening-only alternative discussed above

During the second alternatives evaluation, several widening combinations were evaluated. Each of the following was evaluated for deepening options of 43, 45, 48, 50, 53, and 55 feet with an extension of the Entrance Channel from 8 to 16.5 miles.

- Maintain existing 500- to 400-foot width of the inshore channels to Port of Beaumont at depths of 45, 48, and 50 feet;
- Reducing the deepened Sabine Bank Channel from 800 feet wide to 700 feet wide through the end of the extension channel;
- Selective widening (600- and 700-foot widths) from Sabine Pass Channel station 180+00 to Port Arthur Canal station 275+00 (long reach);
- Selective widening (600- and 700-foot widths) from Sabine Pass Channel Station 265+00 to Port Arthur Canal Station 85+00 (short reach);
- Selective widening (500-, 600-, and 700-foot widths) in the Sabine-Neches Canal;
- Selective widening (600- and 700-foot widths) in the Neches River Channel. Deepening and widening of the Taylor Bayou Channels and Basins;
- Constructing a 12-foot-deep by 150-foot-wide barge shelf from the Port Arthur Junction Area to the mouth of the Neches River; and
- Adding various combinations of up to eight turning basins and/or anchorage basins on the Neches River Channel.

Several of these alternatives were eliminated at the conclusion of the second screening. The alternative mode of commodity transport (LOOP and BOOTS) and the VTS alternatives would help with improving safety along the existing channel (by reducing vessel traffic or better managing the traffic). However, these alternatives do not address the navigational efficiency of the waterway and would not allow the vessels utilizing the channel to load more fully. The potential relaxation of the current transit rules by the pilots was evaluated but screened out as not implementable because the pilots do not support this course of action. Therefore, all of the nonstructural plans were eliminated from further consideration. The widening alternatives included widening of the Sabine Pass and Port Arthur Canal channel from 500 to 700 feet. Although the widening in combination with the deepening of the channel was economically justified, the widening alone did not provide a benefit to cost ratio equal to or greater than 1.0. Therefore, the widening alternative for this reach was not an incrementally justified feature and was eliminated from further evaluation. Depths less than 45 feet and greater than 50 feet were also eliminated from further screening, because the economic analysis indicated that the NED depth was likely between 48 and 50 feet.

In summary, since structural alternatives (e.g., deepening the channel) were the only alternatives that would fully address the project objective of navigational efficiency, only the No-Action Alternative and some structural alternatives for improvements to the SNWW navigation system were carried forward for detailed analysis. Among all of the structural alternatives, only six depths (45, 46, 47, 48, 49, and 50 feet) were carried forward into detailed evaluation.

2.3 EVALUATION OF FINAL ALTERNATIVES

2.3.1 Alternatives Advanced for Final Screening

At the conclusion of the second screening, only the No-Action Alternative and six structural alternatives for improvements to the SNWW deep-draft navigation system were advanced into detailed screening. The barge shelf alternative was dropped from further consideration when implementation of the VTS improved communication between deep-draft vessels and barges, thereby providing a nonstructural solution for the barge shelf. The three nonstructural alternatives for deepening the deep-draft channel had been eliminated from further consideration, as described above. Structural alternatives evaluated during this final screening phase are listed below. Comparative channel dimensions and dredging quantities are provided in Table 2.3-1.

- Deepening the SNWW to Beaumont to 45, 46, 47, 48, 49, or 50 feet (Alternatives A through F, respectively, in Table 2.3-1) with an extension of the Entrance Channel ranging from 8 to 16.5 miles in length, a 700-foot-wide Sabine Bank and Extension Channel, and deepening and widening the Taylor Bayou Channels and Basins.

Adding various combinations of up to eight turning basins and/or anchorage basins to the 45-, 46-, 47-, 48-, 49-, and 50-foot Neches River Channel deepening alternatives (Alternative G).

2.3.2 Comparison of Alternatives and Selection of the Preferred Alternative

The selection of the Preferred Alternative (Alternative D) from the alternatives listed above was based upon a comparison of economic, engineering, environmental, and socioeconomic factors presented in Table 2.3-1. The economic analysis presented in Chapter V of the FFR identified the alternative described below as the plan that maximizes net excess benefits for deepening the SNWW. The Preferred Alternative is called the Selected Plan, and ultimately, the Recommended Plan, in the FFR. The Preferred Alternative, presented as the last alternative in subsection 2.3.1, is described in detail below:

Table 2.3-1
SNWW Alternatives Comparison Table
Screened Alternatives Analysis Matrix - Potential Impacts to Evaluation Criteria

Note Column Letter is for reference in this table ONLY	No-Action Alternative	Alternative A	Alternative B	Alternative C	Alternative D (Preferred Alternative)	Alternative E	Alternative F	Alternative G
ALTERNATIVES	Maintain existing 40-foot-deep by 800-foot-wide by 22-mile-long Sabine Bank and Outer Bar Channels, transitioning to 500 feet wide in the Sabine Pass Jetty Channel, and 400-x-40-foot-deep channel to Beaumont	45-Foot Channel to Beaumont with an 8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins.	46-Foot Channel to Beaumont with a 9.7-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	47-Foot Channel to Beaumont with a 11.4-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	48-Foot Channel to Beaumont with a 13.2-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	49-Foot Channel to Beaumont with a 14.8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	50-Foot Channel to Beaumont with a 16.5-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	Up to eight Neches River Turning and Anchorage Basins
PLAN COMPARISON								
Construction Dredging Note: All totals in this section are approximate								
Inshore SNWW Navigation Channels and Basins	None	35.1 mcy	41.9 mcy	48.8 mcy	54.4 mcy	61.3 mcy	67.2 mcy	8.2 mcy
Offshore SNWW Navigation Channel	None	29.2 mcy	33.8 mcy	38.4 mcy	43 mcy	48.6 mcy	54.1 mcy	NA
Total	NA	64.3 mcy	75.7 mcy	87 mcy	98 mcy	109.9 mcy	121.3 mcy	8.2 mcy
Maintenance Dredging (50-year plan) Note: All totals in this section are approximate								
Inshore SNWW Navigation Channels and Basins	245 mcy	249 mcy	258.4 mcy	267.6 mcy	280.6 mcy	289.9 mcy	295 mcy	8.4 mcy
Offshore SNWW Navigation Channel	161 mcy	332.8 mcy	345.1 mcy	357.2 mcy	369.8 mcy	382 mcy	394.2 mcy	0.0 mcy
Total	407 mcy	581.8 mcy	603.5 mcy	624.8 mcy	650.4 mcy	671.9 mcy	689.2 mcy	8.4 mcy
Dredged Material Placement (50-year plan)								
Upland PAs	16 existing PAs with periodic raising of containment levees.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	16 existing PAs with higher containment levees; new cells at existing PAs (18A and 24A).	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative; marginal additional quantities already provided for in upland PAs.
Neches River Beneficial Use (BU) Feature	None. No suitable new work material available to construct containment levees.	New work and maintenance material quantities expected to be lower than Preferred Alternative, marginally reducing size of Neches River BU Feature.	New work and maintenance material quantities expected to be lower than Preferred Alternative, marginally reducing size of the Neches River BU Feature.	New work and maintenance material quantities expected to be lower than Preferred Alternative, marginally reducing size of the Neches River BU Feature.	New work material is used beneficially to construct this BU feature at Rose City, Bessie Heights, and Old River Cove. No material from the offshore channels would be used beneficially.	New work and construction material quantities expected to be higher than the Preferred Alternative. Increasing size of BU feature is unlikely since there are limited areas remaining near the channel that would be least-cost placement alternatives.	New work and construction material quantities expected to be higher than the Preferred Alternative. Increasing size of BU feature is unlikely since there are limited areas remaining near the channel that would be least-cost placement alternatives.	Material quantities from the turning/anchorage basins would be used beneficially, but quantities are so small that they would not significantly affect size of the size of the Neches River BU Feature.
Gulf Shore BU Feature	Nourishment of 3 miles of Texas and Louisiana Point shorelines, alternating every 3 years. Material from offshore channels is not being used beneficially.	Quantity of maintenance material will be less than that available with Preferred Alternative, but nourishment would still occur over 3 miles of shoreline at both Texas and Louisiana Points, alternating every 3 years for 50 years.	Quantity of maintenance material will be less than that available with Preferred Alternative, but nourishment would still occur over 3 miles of shoreline at both Texas and Louisiana points, alternating every 3 years for 50 years.	Quantity of maintenance material will be less than that available with Preferred Alternative, but nourishment would still occur over 3 miles of shoreline at both Texas and Louisiana points, alternating every 3 years for 50 years.	Same as No-Action Alternative	Quantity of maintenance material would be more than that available with the Preferred Alternative, but nourishment would still occur over 3 miles of shoreline at both Texas and Louisiana points, alternating every 3 years for 50 years.	Quantity of maintenance material would be more than that available with the Preferred Alternative, but nourishment would still occur over 3 miles of shoreline at both Texas and Louisiana Points, alternating every 3 years for 50 years.	Not applicable
ODMDS	4 existing ODMDSs. No size increase is projected; sites are dispersive.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	4 existing ODMDSs and designation of 4 new ODMDSs	Same as Preferred Alternative	Same as Preferred Alternative	Not applicable
EVALUATION CRITERIA								
Water Quality								
Water Column Effects	Turbidity during periodic maintenance dredging of existing Federal and non-Federal channels, basins, and berthing areas; best management practices employed during placement activities to ensure minimal effects on turbidity.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Turbidity during construction up to 1 mile downcurrent from cutter or drag head. Little, if any, difference in turbidity during periodic maintenance dredging of the navigation channels, basins, and berthing areas. Best management practices employed during placement activities ensure minimal turbidity and no release of contaminated materials. Neches River BU Feature would result in net benefit to water quality in study area,	About the same as Preferred Alternative	About the same as Preferred Alternative	Turbidity during construction up to 1 mile downcurrent from cutter or drag head. Little, if any, difference in turbidity during periodic maintenance dredging of navigation channels, basins, and berthing areas. Best management practices employed during placement activities ensure minimal turbidity and no release of contaminated materials.
Sediment Quality								
Surficial Sediments	Alternative is not expected to change the quality of surficial sediments.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Data from physical, chemical, and bioaccumulation studies indicate that construction material from this Alternative is suitable for ocean placement and use in BU features.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative

Table 2.3-1
SNWW Alternatives Comparison Table
Screened Alternatives Analysis Matrix - Potential Impacts to Evaluation Criteria

Note Column Letter is for reference in this table ONLY	No-Action Alternative	Alternative A	Alternative B	Alternative C	Alternative D (Preferred Alternative)	Alternative E	Alternative F	Alternative G
ALTERNATIVES	Maintain existing 40-foot-deep by 800-foot-wide by 22-mile-long Sabine Bank and Outer Bar Channels, transitioning to 500 feet wide in the Sabine Pass Jetty Channel, and 400-x-40-foot-deep channel to Beaumont	45-Foot Channel to Beaumont with an 8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins.	46-Foot Channel to Beaumont with a 9.7-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	47-Foot Channel to Beaumont with a 11.4-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	48-Foot Channel to Beaumont with a 13.2-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	49-Foot Channel to Beaumont with a 14.8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	50-Foot Channel to Beaumont with a 16.5-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	Up to eight Neches River Turning and Anchorage Basins
Sediment Quality, cont'd								
Maintenance Material	Most material from inshore channel reaches is currently placed in upland confined PAs. Data from physical, chemical, and bioaccumulation studies indicate no cause for concern from effluent. Material from Section 5 would be used in the Gulf Shore BU Feature. Based upon past experience with SNWW testing, material is expected to be environmentally acceptable under all applicable regulations.	The quantity of maintenance material from inshore and offshore channel reaches would be less than the Preferred Alternative. The source of the material is the same as the No-Action Alternative. Material would be used beneficially at the Neches River and Gulf Shore BU features. Based upon past experience with the testing on the SNWW material, material is expected to be environmentally acceptable under all applicable regulations.	About the same as Alternative A	About the same as Preferred Alternative	The quantity of maintenance material from inshore channel reaches would increase 15% over the No-Action Alternative; in offshore reach the quantity would increase 130%. The source of the material is the same as the No-Action Alternative. Material would be used beneficially at the Neches River and Gulf Shore BU features. Based upon past experience with the testing on the SNWW material, material is expected to be environmentally acceptable under all applicable regulations.	About the same as Preferred Alternative	The quantity of maintenance material from inshore and offshore channel reaches would be higher than the Preferred Alternative.	Turning and anchorage basins in this alternative are located immediately adjacent to the navigation channel, in relict Neches River oxbows. The relict oxbow channels maintain circulation with the larger river and navigation channel. Slower relative velocities in the oxbows may result in higher shoaling rates. However, the turning/anchorage basins would not be expected to add significant maintenance dredging quantities due to their small size relative to the navigation channel.
Hydrology								
Circulation, Exchange, Velocities	Increases in tidal exchange, velocities and water surface elevations would be expected with "most likely" RSLR of 1.1 feet.	Deeper navigation channel would allow greater tidal circulation and exchange with Gulf than No-Action Alternative. Average water elevations would be negligibly higher in most places, though lower than the Preferred Alternative. Velocity magnitudes would be slightly higher, but absolute magnitudes are small.	Same as Alternative A	Same as Preferred Alternative	Deeper navigation channel would allow greater tidal circulation and exchange with Gulf than No-Action Alternative. Average water elevations are negligibly higher, averaging less than 0.8 inch. Velocity magnitudes would be slightly higher, but absolute magnitudes are small.	Deeper navigation channel would allow greater tidal circulation and exchange with Gulf than No-Action Alternative. Average water elevations would be slightly higher in most places, and slightly higher than the Preferred Alternative. Velocity magnitudes would be slightly higher, but absolute magnitudes are small.	About the same as Alternative E	The turning/anchorage basin Alternative would have no effect on tidal circulation or exchange.
Freshwater Flows	Future freshwater inflows determined by precipitation, demand and supply strategies, and the Neches River and Sabine River Water Authorities in accordance with State and Federal operating permits.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Alternative will have no effect on freshwater inflows; however, by slight tidal exchange increases anticipated, conveying outflows to the Gulf marginally faster than under the No-Action Alternative.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative
Sediment Transport - Inshore Channels	The amount of sediment-laden run-off is likely to increase under the No-Action Alternative due to climate change. Low bottom velocities in some areas result in higher than average shoaling rates. These channel segments are portions of the Sabine Pass Channel near the mouth of Sabine Lake, the Port Arthur and Taylor Bayou Junction in the Sabine-Neches Canal, and a downstream section of the Sabine-Neches Canal.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher shoaling rate than the No-Action Alternative. The channel prism would be smaller than alternatives B through F.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher shoaling rate than the No-Action Alternative. The channel prism would be smaller than Alternatives C through F.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher shoaling rate than the No-Action Alternative. The channel prism would be smaller than alternatives D through F.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher sheeting rate than the No-Action Alternative and Alternatives A through C.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher sheeting rate than the No-Action Alternative and Alternatives A through D.	This Alternative will have a larger volume below the existing river bed than the No-Action Alternative, resulting in higher sheeting rate than the No-Action Alternative and alternatives A through E.	Turning and anchorage basins in this Alternative are located immediately adjacent to the navigation channel, in relict Neches River oxbows. The relict oxbow channels maintain circulation with the larger river and navigation channel. Slower relative velocities in the oxbows may result in higher shoaling rates.
Coastal Shoreline Erosion	Coastal shoreline erosion would continue and accelerate on the Texas Gulf shoreline, beyond 0.5 mile from the West Jetty. The Louisiana Gulf shoreline is not eroding in the study area. The shoreline within 0.5 mile of each jetty is accreting.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 2–4 inches/year.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 2–4 inches/year.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 3–5 inches/year.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 3–5 inches/year.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 4–6 inches/year.	There would be a slight reduction in the accretion rate near both jetties, but between 0.5 and 3.5 miles from both jetties, erosion would increase by 4–6 inches/year.	Not applicable - inshore turning and anchorage basins would have no effect on offshore conditions.
Inland Shoreline Erosion	Continuation of significant channel shoreline erosion along the Sabine-Neches Canal and portions of the Port Arthur Canal. Acceleration of shoreline recession of east Sabine Lake.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Confined inland channel erosion rates reduced relative to the No-Action Alternative because of the larger channel and the fewer vessel trips predicted under this Alternative. East Sabine Lake shoreline recession same as the No-Action Alternative.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative
Salinity	Salinity intrusion from existing SNWW Ship Channel, GIWW and Calcasieu Ship Channel would continue to affect majority of study area. Salinity would increase between 0 and 2 parts per thousand (ppt) due to RSLR under median flows.	Salinity would increase from 0 to 1.3 ppt over No-Action Alternative under median flows.	Salinity would increase from 0 to 1.5 ppt over the No-Action Alternative under median flows.	Salinity would increase from 0 to 1.6 ppt over the No-Action Alternative under median flows.	Saltwater wedge penetration expected farther up the SNWW navigation channels than under the No-Action Alternative. Salinities would increase from 0 to 1.8 ppt over the No-Action Alternative under median flows.	Salinity would increase from 0 to 2.0 ppt over the No-Action Alternative under median flows.	Salinity would increase from 0 to 2.2 ppt over the No-Action Alternative under median flows.	The addition of turning and anchorage basins on the Neches River Channel would have no measurable effect on salinity because of their small size relative to the existing tidal prism.

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ALTERNATIVES	Maintain existing 40-foot-deep by 800-foot-wide by 22-mile-long Sabine Bank and Outer Bar Channels, transitioning to 500 feet wide in the Sabine Pass Jetty Channel, and 400-x-40-foot-deep channel to Beaumont	45-Foot Channel to Beaumont with an 8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins.	46-Foot Channel to Beaumont with a 9.7-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	47-Foot Channel to Beaumont with a 11.4-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	48-Foot Channel to Beaumont with a 13.2-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	49-Foot Channel to Beaumont with a 14.8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	50-Foot Channel to Beaumont with a 16.5-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	Up to eight Neches River Turning and Anchorage Basins
Hydrology, cont'd								
Groundwater	Groundwater in the upper Chicot aquifer in the study area ranges from slightly to moderately saline, and increases in salinity as it nears the coast. Current activities that may affect groundwater (i.e., well extraction and existing dredging activities) are expected to continue. RSLR would adversely affect freshwater aquifers.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	Navigation channel deepening under this Alternative would not be expected to increase salinities in the aquifer beyond those already present under the No-Action Alternative. No impacts would be expected with the additional placement of dredged material into upland PAs under this alternative.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Hazardous Materials								
	Evaluation and clean-up of nine priority sites of concern would continue under the No-Action Alternative	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	Four of the nine priority hazardous materials sites are located adjacent to the SNWW. These sites present minimal potential for risk to this alternative. PA 17 contains hazardous materials from landfill and dumping activities. The type and extent of these hazardous materials must be determined before the PA can be used.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Air Quality								
Land-side Mobile Emissions	Land-side emissions in support of waste material placement will be maintained consistent with the level of existing maintenance dredging activities.	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 6% less than for the Preferred Alternative with a corresponding reduction in impact compared to the Preferred Alternative.	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 4% less than for the Preferred Alternative with a corresponding reduction in impact compared to the Preferred Alternative.	About the same as the Preferred Alternative	Air contaminant emissions from the combustion of fuel in equipment used for placement activities would result in minor short-term impacts on air quality in the immediate vicinity of the project area.	About the same as the Preferred Alternative	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 4% more than for the Preferred Alternative with a corresponding increase in impact compared to the Preferred Alternative.	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be small and would result in correspondingly minor short-term impacts on air quality in the immediate vicinity of the project area.
Ocean-Going Transit Emissions	Maintenance dredging activities will result in air emissions impact to project area.	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 59% less than for the Preferred Alternative with a corresponding reduction in impact compared to the Preferred Alternative.	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 43% less than for the Preferred Alternative with a corresponding reduction in impact compared to the Preferred Alternative.	About the same as the Preferred Alternative	Air contaminant emissions from the combustion of fuel in equipment used for dredging and placement activities would also result in short-term impacts on air quality in the immediate vicinity of the project area.	About the same as the Preferred Alternative	Air contaminant emissions from the combustion of fuel in equipment used for placement activities are estimated to be about 52% more than for the Preferred Alternative with a corresponding increase in impact compared to the Preferred Alternative.	Air contaminant emissions from the combustion of fuel in equipment used for dredging and placement activities are estimated to be small and would also result in correspondingly minor short-term impacts on air quality in the immediate vicinity of the project area.
Construction Emissions	Not applicable.	Air contaminant emissions from construction and dredging activities are expected to be about 18% less than for the Preferred Alternative with a corresponding reduction in short-term impacts on air quality in the immediate vicinity of the project area compared to the Preferred Alternative.	Air contaminant emissions from construction and dredging activities are expected to be about 12% less than for the Preferred Alternative with a corresponding reduction in short-term impacts on air quality in the immediate vicinity of the project area compared to the Preferred Alternative.	About the same as the Preferred Alternative	Pollutant emissions from construction and dredging activities will result in short-term impacts on air quality in the immediate vicinity of the project site. Construction of the proposed project would result in a 1 to 2% increase in emissions of nitrogen oxides (NO_X) above those resulting from existing emissions sources in the Beaumont-Port Arthur area.	About the same as the Preferred Alternative	Air contaminant emissions from construction and dredging activities are expected to be about 14% more than for the Preferred Alternative with a corresponding reduction in short-term impacts on air quality in the immediate vicinity of the project area compared to the Preferred Alternative.	Air contaminant emissions from construction and dredging activities are estimated to be much less than for the Preferred Alternative and will result in minor short-term impacts on air quality in the immediate vicinity of the project site.
General Conformity	Not required for No-Action Alternative.	A General Conformity Determination for NO_X emissions would likely be required for evaluation of emissions from construction activities.	A General Conformity Determination for NO_X emissions would likely be required for evaluation of emissions from construction activities.	A General Conformity Determination for NO_X emissions would likely be required for evaluation of emissions from construction activities.	A General Conformity Determination for NO_X emissions was submitted to TCEQ. TCEQ provided written concurrence that emissions are conformant with the Texas SIP for the Beaumont-Port Arthur region.	A General Conformity Determination for NO_X emissions would likely be required for evaluation of emissions from construction activities.	A General Conformity Determination for NO_X emissions would likely be required for evaluation of emissions from construction activities.	A General Conformity Determination would not be required for this construction.

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Habitat Effects					*Note: All CIP habitat impacts in Texas would be minimized and offset by the DMMP and no mitigation is required. All mitigation measures are located in Louisiana, compensating for salinity increase and loss to biological productivity.*			
Terrestrial and Emergent Vegetation (uplands and bottomland hardwoods)	No change to existing conditions for most uplands and bottomland hardwood areas. Most of the area is an upland ridge covered by primarily tallow woods; 86 acres are fresh marsh. Productivity impacts of this conversion are fully offset by productivity benefits of the Neches River BU Feature.	All other alternatives would use the same upland PAs as the Preferred Alternative.	All other alternatives would use the same upland PAs as the Preferred Alternative.	All other alternatives would use the same upland PAs as the Preferred Alternative.	No change to existing conditions for most uplands and bottomland hardwood areas. Two upland areas are being converted to new PA cells. In addition to PA 24A (see No-Action), another 71 acres of disturbed, low-quality scrub habitat would be converted to new PA 18A. Five currently inactive PAs (23A, 25A, 26, 27C, and 27D) would be returned to active use. All have been modified extensively by past placement activities and levees that isolate them and prevent contributions to the adjacent wetlands and riparian corridor. All contain degraded habitat with low habitat values, primarily roosting habitat for birds and some wildlife cover.	All other alternatives would use the same upland PAs as the Preferred Alternative.	All other alternatives would use the same upland PAs as the Preferred Alternative.	No incremental impacts to terrestrial and emergent vegetation from turning/anchorage basins.
Submerged Aquatic Vegetation (SAV)	Existing rate of emergent marsh loss would increase size of open-water areas at the expense of intertidal habitat, reduce marsh edge, and protected shallow-water habitat for SAV. Salinity-tolerant SAV species would expand coverage due to RSLR.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Construction dredging would not affect SAV. The Neches River BU Feature would result in net increase in shallow-water ponds and sinuous channels, which provide still, protected waters beneficial to SAV. SAV coverage would be expected to increase over the No-Action Alternative in BU and mitigation areas.	About the same as Preferred Alternative	About the same as Preferred Alternative	Turning and anchorage basins in this alternative are located immediately adjacent to the navigation channel, in relict Neches River oxbows. The relict oxbows maintain circulation with the larger river and navigation channel. Protected shallow-water areas at oxbow edge that may provide SAV habitat would be temporarily affected during construction.
Freshwater Aquatic Habitat (freshwater streams, fresh marsh and swamp)	Existing high rate of marsh loss would continue under No-Action Alternative due to combined effect of RSLR, and altered hydrology and salinity levels. Swamps subject to pulses of higher salinity during low-flow conditions.	Generally the same as the Preferred Alternative because there would be no change to upland PAs and no significant differences in salinity impacts. New work and maintenance material quantities are expected to be lower than the Preferred Alternative, marginally reducing the size of Neches River BU Feature.	About the same as Alternative A	About the same as the Preferred Alternative	Impacts would consist of the conversion of 86 acres of wetlands to an upland confined placement area and small reductions in biological productivity due to small increase in salinity over 35,600 acres of fresh marsh and 804 acres of swamps in Texas and Louisiana. The Nueces River BU Feature would offset all productivity from small reductions in biological productivity due to a small increase in salinity. Compensatory mitigation would replace the lost biological productivity to fresh marsh and swamp in Louisiana.	Generally the same as the Preferred Alternative because there would be no change to upland PAs, and no significant differences in salinity impacts. New work and maintenance material quantities are expected to be higher than the Preferred Alternative but no change in the size of the Neches River BU Feature would be expected,	About the same as Alternative E	No freshwater habitat would be affected by turning/anchorage basin dredging or placement activities.
Estuarine Habitats (Sabine Pass, Sabine Lake, Neches and Sabine rivers and tributaries; Intermediate, Brackish, and Saline Marsh)	Existing high rate of marsh loss would continue under No-Action Alternative due to combined effect of RSLR, and altered hydrology and salinity levels. Water column turbidity and nutrient release associated with periodic, ongoing maintenance dredging would continue, although significant impacts are not anticipated.	Generally the same as the Preferred Alternative because there would be no significant difference in salinity impacts. New work and maintenance material quantities are expected to be lower than the Preferred Alternative, marginally reducing the size of Neches River BU Feature.	About the same as Alternative A	About the same as the Preferred Alternative	Small reductions in biological productivity due to small increase in salinity over large areas of estuarine marsh habitat (over 22,200 acres in Texas and 153,000 acres in Louisiana). Short-term impacts to benthic organisms are expected with channel dredging and the borrow trench and access channel for compensatory mitigation in the Willow Bayou marshes. Productivity impacts in Texas would be fully offset by benefits of Neches River and Gulf Shore BU features. Compensatory mitigation in Louisiana would fully compensate productivity losses to marshes and benthic resources.	Generally the same as the Preferred Alternative because there would be no significant difference in salinity impacts. New work and maintenance material quantities are expected to be higher than the Preferred Alternative but no change in the size of the Neches River BU Feature would be expected.	About the same as Alternative E	Small, one-time impact to benthic habitat with construction of new or expanded turning and anchorage basins.

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Habitat Effects, cont'd								
Marine Aquatic Habitat	Water column turbidity and nutrient release associated with periodic, ongoing maintenance dredging and placement would continue, although significant impacts would not be anticipated.	Shorter Entrance Channel Extension would result in fewer short-term impacts to benthic organisms than the Preferred Alternative. Reasonable and prudent measures to avoid impacts to sea turtles would be the same for all alternatives.	About the same as Alternative A	About the same as Preferred Alternative	Short-term impacts to benthic organisms are expected with creation of 4 new ODMDSs. Dredging impacts to bottom-feeding and pelagic organisms such as sea turtles may occur with hopper dredging, but reasonable and prudent measures to avoid impacts would be instituted with an avoidance plan.	Longer Entrance Channel Extension would result in greater short-term impacts to benthic organisms than the Preferred Alternative. Reasonable and prudent measures to avoid impacts to sea turtles would be the same for all alternatives.	About the same as Alternative E	Not Applicable
Terrestrial Wildlife Habitat	Ongoing maintenance dredging, including placement, would not result in additional impacts to terrestrial wildlife habitats (upland grasslands and coastal prairies, and upland, nonwetland riparian woodlands and forests).	All other alternatives would use the same upland PAs as the Preferred Alternative	All other alternatives would use the same upland PAs as the Preferred Alternative.	All other alternatives would use the same upland PAs as the Preferred Alternative.	No impact to Louisiana swamp and small productivity impact to 804 acres of Texas swamp. DMMP Neches River restoration would offset all impacts in Texas and results in excess of 843 Average Annual Habitat Units (AAHUs). Two upland areas are being converted to new PA cells. One 187-acre upland area would be converted to new PA cell 24A. Most of the area is an upland ridge covered primarily by tallow woods; however, 86 acres are fresh marsh. Another 71 acres of disturbed, low-quality scrub habitat would be converted to new PA cell 18A. Productivity impacts of this conversion are fully offset by productivity benefits of the Neches River BU Feature.	All other alternatives would use the same upland PAs as the Preferred Alternative.	All other alternatives would use the same upland PAs as the Preferred Alternative.	No incremental impacts to terrestrial wildlife habitat from turning/anchorage basins.
Essential Fish Habitat (EFH)								
	Ongoing maintenance dredging, including placement, would not result in additional permanent impacts to EFH; temporary impacts due to sedimentation, turbidity, and nutrient release are temporary and episodic.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Turbidity would be temporary; localized impact during dredging and ODMDS material placement; benthos would be affected until natural recovery occurs. The DMMP and mitigation measures propose 13,053 acres EFH emergent marsh (approximately 75%) and open shallow water (approximately 25%).	About the same as Preferred Alternative	About the same as Preferred Alternative	None
Endangered and Threatened (E&T) Species								
E&T Vertebrates	Ongoing maintenance dredging, including placement, may result in sedimentation and alter hydrology; potential impacts to sea turtles are covered by the Gulf Regional Biological Opinion for USACE's maintenance dredging activities.	Same as the preferred alternative for piping plover and its critical habitat. Small reductions in potential impacts to sea turtles due to reduced dredging time as compared to the Preferred Alternative.	About the same as Alternative A	About the same as Alternative A	Proposed beach nourishment at Louisiana Point would occur along 3 miles of piping plover critical habitat; however, positive effects for the plover are anticipated (may affect, but not likely to adversely affect). A Biological Opinion from USFWS has concurred with this assessment. New work dredging (construction) is likely to adversely affect but not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, and green sea turtles. In a draft Biological Opinion, NMFS anticipates an incidental take of 4 sea turtles and has identified reasonable and prudent measures to be taken to minimize effects during construction. Potential impacts to sea turtles from maintenance dredging are covered by the Gulf Regional Biological Opinion for USACE's dredging activities.	About the same as Alternative A	About the same as Alternative A	None
E&T Invertebrates	None	None	None	None	None	None	None	None
E&T Plants	None	None	None	None	None	None	None	None

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Cultural Resources								
Terrestrial Archeological Sites	Under the No-Action Alternative, archeological sites located in eroding marsh areas would increasingly be exposed to the erosive effects of wind and tidal action. Archeological sites along the SNWW navigation channel would continue to be exposed to the erosive forces of boat wakes; this would increase in the future as vessel trips rise to support projected imports under the current lightering requirements.	About the same as Preferred Alternative	About the same as Preferred Alternative	About the same as Preferred Alternative	Archeological site impacts in and around margins of DMMP BU features and Mitigation Measures would be avoided to the greatest extent possible. No unavoidable impacts have been identified. The restoration of eroding marsh areas will stabilize landforms, create stable marsh buffers, and prevent further erosion of sites. Future vessel trips and erosive boat wakes are expected to be reduced relative to the No-Action Alternative.	About the same as Preferred Alternative	About the same as Preferred Alternative	None
Historic Structures	No impacts to historic structures are expected to occur with the No-Action Alternative.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	The alternative will not affect the Sabine Pass Lighthouse, Rainbow Bridge, or any known historic structures.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Shipwrecks	Maintenance dredging would continue with the potential to affect unidentified shipwrecks along the margins of the SNWW.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	The Alternative would not affect the USS *Clifton* wreck site. Additional investigations would be conducted to determine if unknown shipwrecks eligible for the National Register of Historic Places would be adversely affected. If adverse effects to eligible shipwrecks are identified, they will be addressed in accordance with requirements of the Historic Properties Programmatic Agreement.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Socioeconomics								
Land Use; Population; Community Values, Housing, Infrastructure and Services	Residential and industrial development would continue on its slow to moderate path. Community facilities, services, and housing would not increase due to low population trends. Land use plans and development would continue to follow neighboring cities' patterns. Some industrial sites along the ship channel are expanding, and some new facilities are being constructed.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	The Preferred Alternative would likely promote the development of some industrial sites along the ship channel, but population growth is not expected to change much from present. The Preferred Alternative would not divide, isolate, or separate residents from community facilities.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Recreation; Aesthetics	Recreational fishing and wildlife watching would remain as the major activity for recreation in the SNWW. Under the No-Action Alternative, 2,853 acres of marsh land, 871 acres of shallow-water habitat, and 6 miles of shoreline would not be restored. The marsh degradation process would proceed unchecked, eventually adversely affecting recreational fishing. The No-Action Alterative would not affect scenic and aesthetic values.	Similar to Preferred Alternative	Similar to Preferred Alternative	Similar to Preferred Alternative	Under the Preferred Alternative, 2,853 acres of marsh land, 871 acres of shallow water habitat, and 6 miles of shoreline would be restored, which would provide more fishing and wildlife watching for this area, thus enhancing the life for recreational use and improving some natural aesthetic values.	Similar to Preferred Alternative	Similar to Preferred Alternative	Same as Preferred Alternative
Environmental Justice (EJ)	The No-Action Alternative action would not impact minority or low-income persons.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	Populations includes 59.6% white persons, 26.7% black or African Americans, and 9.6% Hispanic or Latino persons. Therefore, the Preferred Alternative would not be located within a minority area. The median household income for the study area population is $28,884, which is above the Department of Health and Human Services 2006 poverty guideline of $20,000 for family of four; therefore, the Preferred Alternative would not be located in low-income area. No adverse or disproportionately high impacts on minority or low-income persons is anticipated from the Preferred Alternative.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative

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ALTERNATIVES	Maintain existing 40-foot-deep by 800-foot-wide by 22-mile-long Sabine Bank and Outer Bar Channels, transitioning to 500 feet wide in the Sabine Pass Jetty Channel, and 400-x-40-foot-deep channel to Beaumont	45-Foot Channel to Beaumont with an 8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins.	46-Foot Channel to Beaumont with a 9.7-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	47-Foot Channel to Beaumont with a 11.4-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	48-Foot Channel to Beaumont with a 13.2-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	49-Foot Channel to Beaumont with a 14.8-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	50-Foot Channel to Beaumont with a 16.5-mile by 700-foot-wide extension of the Entrance Channel, and deepening and widening of Taylor Bayou Channels and Basins	Up to eight Neches River Turning and Anchorage Basins
Socioeconomics, cont'd								
Direct wages and salaries; Employment	In 2004, the ports created $877.7 million in direct wages and salaries; 83,692 jobs in Texas and Louisiana at private and public marine terminals along SNWW; 14,987 jobs directly related to activities along the SNWW; 13,628 induced jobs from local purchases from SNWW workers; 55,077 indirect jobs.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	The Preferred Alternative would likely promote the development of industrial sites along the ship channel and a steady historical trend towards increased reliance on these industries; the positive economic effects to the study area economy would be moderate at the least and substantial at best.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Local and Federal Tax Revenues	Local tax revenues: $426.5 million in 2004 generated by activity at marine terminals. Federal revenues: $853 million in 2004 generated by activity at marine terminals.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	The increase in the tax base as a result of the Preferred Alternative would be fairly slow and consistent with historical growth trends.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative
Safety								
	The probability of accidents would increase under the No-Action Alternative as vessel trips rise to support projected imports under the current lightering requirements and as new LNG plants become operational.	Same as Preferred Alternative	Same as Preferred Alternative	Same as Preferred Alternative	Vessel traffic is expected to increase; however, these increases would be lower because of the deeper channel allowing more deep-draft cargo to be carried with fewer vessel trips. As a result, the probability of accidents would decrease relative to the No-Action Alternative.	Same as Preferred Alternative	Same as Preferred Alternative	The addition of turning/anchorage basins on the Neches River Channel under this Alternative provides areas adjacent to the navigation channel where deep-draft vessels can safely wait their turn to dock. More ships can safely use the waterway as compared to the No-Action Alternative.
Commercial Navigation								
	Vessel trips would increase, adding to shipping delays, congestion, and cost. LNG vessels began using the lower waterway in 2008, adding to channel congestion and delays. Average annual benefits of the No-Action Alternative are $5,471.	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $84,917, and the benefit to cost ratio is 1.1.	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $97,117, and the benefit to cost ratio is 1.2.	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $105,540, and the benefit to cost ratio is 1.2.	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $116,334, and the benefit to cost ratio is 1.2 .	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $124,164, and the benefit to cost ratio is 1.2.	Some deep-draft vessels would be able to enter the SNWW more fully loaded, reducing the overall number of vessel trips. Average annual benefits of this alternative are $128,736, and the benefit to cost ratio is 1.2.	The addition of turning/anchorage basins on the Neches River Channel allows more ships to reduce vessel delays as compared to the No-Action Alternative. Average annual benefits are $1,312.

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> Deepening of the SNWW to Beaumont to 48 feet with a 13.2-mile-long by 700-foot-wide Sabine Bank and Extension Channel, existing 500- to 400-foot-wide jetty and inshore channels with the exception of deepening and widening of Taylor Bayou Channels and Basins, and the addition of Neches River Turning/Anchorage Basins 1, 4, and 8 (see figures 2.4-1a–g).

While the economic analysis determined that the 49-foot alternative is the NED plan, the 48-foot alternative is preferred by the non-Federal sponsor and will be recommended as the Locally Preferred Plan. Structural modifications of the Preferred Alternative meet the planning objective for increased navigational efficiency, and DMMP BU features and compensatory mitigation measures effectively avoid or mitigate all unavoidable environmental impacts.

Costs were estimated for all of the alternatives and used to determine the benefit-to-cost ratio in the economic analysis. Included in the costs were dredging, levee construction, relocations (including utility relocations), and O&M costs for the 50-year period of analysis. Ecological mitigation costs for the six depth alternatives were estimated using HS model salinity projections for the 40-, 45-, and 48-foot channel depths. Salinity was chosen as the best factor on which to base interpolations of mitigation costs because it is the primary driver in the ecological modeling that was used to determine the compensatory mitigation plan. The cost interpolation assumed that there would be a linear relationship between predicted salinities for each channel depth at the end of the period of analysis and the cost of mitigation.

Direct ecological effects associated with navigation channel improvements under all proposed alternatives and the placement of dredged material consist of:

- Impacts to benthic organisms and their Gulf, estuarine, and riverine water-bottom habitats would be similar for all alternatives. Benthic organisms are expected to quickly rebound from the short-term impacts of channel dredging, the use of offshore PAs, and the Sabine Lake borrow trench/access channel associated with compensatory mitigation in Louisiana.
- Dredging impacts to bottom-feeding and pelagic organisms such as sea turtles may occur with hopper dredging of offshore channel reaches for all alternatives, but reasonable and prudent measures to avoid impacts would be instituted with an avoidance plan.
- Impacts to marsh would result from the enlargement of one PA under the No-Action Alternative and two PAs under all other alternatives. The new PAs would be small, and the incremental cost associated with one additional PA is too small to affect alternative selection. Most PAs would be enlarged by raising levee heights, which means that the footprint of PA impacts would be similar for all alternatives.
- Impacts to shorebirds and their habitat would result from the regular placement of maintenance material on the Gulf shoreline under all alternatives, including the No-Action Alternative. Birds would be temporarily displaced to nearby habitat during each placement episode. These impacts would be minor and temporary, and the number and footprint of each placement episode would be the same for each alternative.

Indirect effects provide the primary ecological impact of all structural alternatives. Although the SNWW channel is located primarily in Texas, large indirect impacts may occur in both Texas and Louisiana due to small increases in salinity levels causing an increase in wetland loss rates and a decrease in biological productivity in aquatic habitats of the study area. HS modeling indicates that none of the depth alternatives would result in significant impacts to swamp and fresh marsh habitats in the upper reaches of the Sabine and Neches rivers. Salinity impacts of the six depth alternatives to the vast saline through intermediate marshes would be similar, with an average difference between the 45- and 50-foot alternatives of less than 0.5 parts per thousand (ppt).

2.3.3 Sensitivity of Project Alternatives to Relative Sea Level Rise

"*Coastal Sensitivity to Sea-Level Rise: A Focus on the Mid-Atlantic Region*" (U.S. Climate Change Science Program [USCCSP], 2009) synthesizes the state of knowledge regarding possible effects of RSLR on coastal ecosystems and communities. Areas of the Nation's coast are experiencing submergence of low-lying lands, erosion of shores, and conversion of wetlands to open water as a result of RSLR. Studies suggest the rate of RSLR has increased recently and is likely to continue to increase in vulnerable areas. Forecasting impacts of RSLR on specific coastal areas is difficult because of the complexity of coastal ecosystems and ecological processes and uncertainty about regional variation in RSLR. According to USCCSP (2009:1), "Existing studies of sea-level rise vulnerability based on currently available elevation data do not provide the degree of confidence that is optimal for local decision making."

Circular No. 1165-2-211, Water Resources Policies and Authorities Incorporating Sea-level Change Considerations in Civil Works Programs (USACE, 2009a), requires the USACE to incorporate "the direct and indirect physical effects of projected future sea-level change in managing, planning, engineering, designing, constructing, operating, and maintaining USACE projects. . . ." In fulfillment of this requirement, the sensitivity of project alternatives to the full range of potential FWOP changes in sea level has been evaluated. There are a wide range of potential effects related to the full range of RSLR, but the sensitivity of project alternatives would be more limited. In particular, alternatives were evaluated to determine whether the purpose and function of navigation features could be undermined, whether environmental impacts might be exacerbated, and how economic benefits and costs might be affected by sea level change. Nonstructural alternatives were evaluated but eliminated in the second screening; they are therefore not addressed in this analysis.

In order to meet the requirements of Circular No. 1165-2-211, this section evaluates effects of the full range of possible RSLR rates, which were developed in accordance with a specific methodology prescribed in the guidance. RSLR rates that may be appropriate for the project area are discussed in detail in Section 3.3 of Appendix C to this FEIS. The range of RSLR was determined using both tide gage and basal peat data for the local subsidence component of RSLR. Tide gage data reflect the effects of recent historical subsidence. The average rate of RSLR measured at the Sabine Pass tide gage was 0.2 inch/year for the 48-year period between 1958 and 2006 (U.S. Department of Commerce [USDC]-National Oceanic and Atmospheric Administration [NOAA], 2006, 2009). However, there is significant scientific debate concerning the validity of tidal records with respect to the projection of future subsidence rates in the northwest Gulf coastal plain. The relative influence of historic anthropogenic activities in this area (e.g., oil and gas withdrawal) is difficult to quantify. If these activities contributed significantly to recent observations of subsidence, then significant reductions in these activities may result in rapid deceleration of subsidence rates, returning them to long-term average rates best represented by the basal peat data. Deriving RSLR estimates using both basal peat and tide gage data, possible RSLR rates were estimated for the period from 2019 to 2069 to range from 0.3 to 2.8 feet. Possible low, intermediate, and high rates are as follows:

- 0.3 foot, Low (1.83 millimeters [mm]/year), based on basal peat subsidence rates
- 0.7 foot, Intermediate (4.27 mm/year), based on basal peat subsidence rates
- 1.1 feet, Intermediate (6.71 mm/year), based on tide gage subsidence rates (This value was used in the hydrodynamic-salinity modeling of the estuary for this project.)
- 1.5 feet, Intermediate (9.14 mm/year), based on tide gage subsidence rates
- 2.2 feet, High (13.44 mm/year), based on basal peat subsidence rates
- 2.8 feet, High (17.07 mm/year), based on tide gage subsidence rates

An intermediate rate of RSLR (1.1 feet by year 2069) was used as the "most likely" estimate of RSLR in the alternative analysis for this project, in accordance with the USACE planning guidance. The following discussion describes possible ways that high and low RSLR might affect the project alternatives and the recommended action. There are relatively little data and analysis currently available that would permit a detailed, quantitative analysis of the impacts of each of the possible RSLR scenarios on the project alternatives. Ways in which different RSLR rates might affect project design and impacts are presented in Table 2.3-2.

In general, the functioning of the navigation features associated with all alternatives (channel depths of 45 through 50 feet, turning/anchorage basins, PAs/ODMDSs, and the BU features) would not be significantly affected by the full range of potential sea level change. Construction dredging would occur within 10 years and would not be affected by future rates of RSLR. While shoaling rates toward the end of the period of analysis could increase due to an enlarged cross section and greater saltwater penetration, this small effect would probably be offset by increased overall water depths. PAs and BU features have been designed to accommodate sea level changes through the high RSLR range. PAs are located at sufficiently high elevations to withstand the potential rise, and appropriate erosion control measures are included. BU features are located well inland on the Neches River, and they have been designed with erosion control features that would survive the full range of RSLR. The addition of mineral soils and higher marsh elevations would provide stable landforms. Biomass accumulation and sediment from adjacent terrace margins should enable restored marsh vegetation to maintain itself even with the high RSLR rate.

The protection of human health and improvements in safety are not project objectives and therefore potential effects on calculated risk are not applicable. RSLR does not affect the functioning of the various depth alternatives or vessel safety. At the intermediate and high rates of RSLR, a significant increase in

Table 2.3-2
Relative Sea Level Rise Sensitivity of Project Alternatives

Sensitivity of Design				Sensitivity of Impacts		
Navigation Channel Alternatives A-G	DMMP (PAs/ODMDSs)	DMMP (BU Features)	Mitigation Measures	Human Health/Safety	Environmental Impacts	Economic Costs/Benefits
Low Rate (0.3 feet over 50 years)						
No significant effect for any depth alternative. Low range of future RSLR is lower than recent historical rate.	DMMP: no change to existing shoaling rate and maintenance dredging expected. All PAs designed for intermediate RSLR rate.	All BU features were designed to accommodate intermediate RSLR; low rate would have no effect.	All mitigation measures were designed to accommodate intermediate RSLR; low rate would have no effect.	RSLR does not affect the functioning of the various depth alternatives or vessel safety. Small increase in tidal surge penetration due to low RSLR rate would be expected; tidal surge protection is not a project objective. No increase in tidal surge impacts due to project.	Primary project impact is result of greater salinity intrusion. Salinity difference for low RSLR is within one standard deviation of the salinity difference between FWOP and FWP.	Benefits and costs of the deepened navigation channel would be the same as FWP forecast.
Intermediate Rate (0.7 to 1.5 feet over 50 years)						
No significant effect for any depth alternative. Rising water depth offset by increased shoaling. Potential impacts to Sabine Pass Jetties addressed by separate O&M major rehabilitation project.	DMMP: no significant increase in maintenance dredging for depths greater than 48 ft. Possible rise of water surface elevation is within range used for engineering design of all PAs. No effect to ODMDSs.	Possible RSLR rise is within range used for engineering design of all BU features.	Possible RSLR rise is within range used for engineering design of all mitigation measures.	RSLR does not affect the functioning of the various depth alternatives or vessel safety. Intermediate increase in tidal surge penetration due to RSLR rate; tidal surge protection is not a project objective. No increase in tidal surge impacts due to project.	Salinity impacts were based upon RSLR of 1.1 feet. Salinity difference for range of intermediate RSLR rates is within one standard deviation of the salinity difference between FWOP and FWP.	Benefits and costs of the deepened navigation channel for the full intermediate range would be the same as FWP forecast.
High Rate (2.8 feet over 50 years)						
No significant effect for any depth alternative. Possible small increase in maintenance dredging for all depth alternatives resulting from enlarged cross section and greater saltwater penetration. Potential impacts to Sabine Pass Jetties addressed by separate O&M major rehabilitation project.	DMMP: small increase in levee heights and/or armoring may be needed for some PAs. No significant effect to ODMDSs.	Addition of mineral soils and higher marsh elevations provides more-stable landforms. Biomass accumulation may enable restored marsh vegetation to remain stable relative to high RSLR rate. Erosion control features would survive the full range of RSLR.	Addition of mineral soils and higher marsh elevations provides more-stable landforms. High rate of RSLR could result in submergence and erosion of restored marsh. Monitoring and adaptive management plan have been developed to identify corrective actions that might be needed toward the end of the period of analysis.	RSLR does not affect the functioning of the various depth alternatives or vessel safety. High rate of RSLR would increase tidal surge penetration; tidal surge protection is not a project objective. No increase in tidal surge impacts due to project.	Potential salinity increase with high range of RSLR is still within one standard deviation of the salinity difference between FWOP and FWP. No significant increase in salinity impacts would be expected.	Benefits of the deepened navigation channel would be the same as FWP forecast. No facilities used by shipping industry would be rendered ineffective by the high range of RSLR. O&M costs could increase slightly toward the end of the period of analysis, but not enough to reduce benefit to cost ratio below parity.

tidal surge penetration would be expected, but this would not affect project alternatives because tidal surge protection is not a project objective. Furthermore, HS modeling has determined that little or no increase in water surface elevation would be expected due to the deeper navigation channel.

The primary impact of RSLR on this project may be its potential impact on mitigation measures proposed for the Louisiana marshes along the east side of Sabine Lake. These mitigation measures are planned for marshes that could experience submergence and erosion at the high RSLR rate. In recent decades, marshes in the study area have been able to keep up with rates of 5.6 to 6.5 mm/year, suggesting that these marshes may be able to sustain themselves through rises in the intermediate range of RSLR (4.3 to 9.1 mm/year). The high rate of RSLR (17.1 mm/year) could threaten long-term survivability. Sustainability thresholds are determined by local physical, chemical, climatologic, and hydrologic conditions and cannot be extrapolated to other regions. However, as an example, studies in the mid-Atlantic region indicate that the tipping point for coastal ecosystems could range from an RSLR of as low as 2.0 mm/year to as high as 10 mm/year (USCCSP, 2009). There are relatively little data and analysis currently available that would permit a detailed, quantitative analysis of the impacts of the full range of potential RSLR on the SNWW ecosystem and project alternatives.

A monitoring and contingency/adaptive management plan has been developed to identify corrective actions that could be necessary decades after initial marsh construction (Appendix J). Corrective actions proposed in the contingency plan assume that the low to intermediate rates of RSLR will occur; the high rate is assumed to be unlikely. If monitoring determines that the extent of vegetation coverage does not meet ecological success criteria specified in the monitoring plan, manual planting would be employed to restore the requisite acres of emergent marsh. The ICT would determine whether marsh planting is needed and if so, to what extent and in which areas. Relocation of the mitigation areas to areas that would be protected from the potential effects of the full range of RSLR is not feasible. All intertidal marshes in the study area would be similarly affected by the sea level change because of the extremely low slope of the coastal plain. The option of purchasing credits in a mitigation bank was investigated; however, no mitigation banks exist for this area and resource type.

2.4 PREFERRED ALTERNATIVE

The description of the Preferred Alternative in this section is divided into two primary components, navigation channels improvements and associated elements, and dredged material placement features. Requirements for compensatory mitigation are covered in Chapter 5. General navigation features of the Preferred Alternative consist of navigation channels and basins, and bridge reinforcements. Other project elements required to complete project construction are Aids to Navigation; lands, easements, rights-of-way, and relocations (LERRs); and deep-draft utility relocations. The 50-year DMMP for both new work and O&M consists of ODMDSs, upland PAs, and the Neches River and Gulf Shore BU features. Detailed descriptions for project components are provided later in this chapter.

2.4.1 Navigation Channel Improvements

The description of proposed improvements begins at the farthest point offshore and moves inshore to the Beaumont Turning Basin. Project dimensions for the Preferred Alternative are provided in Table 2.4-1 and all channel sections and stationing are shown on figures 2.4-1a–g.

Table 2.4-1
Project Dimensions for Preferred Alternative

Reach	Station	to	Station	Bottom Width (feet)	Project Depth (feet)	Side Slope*
Extension Channel	165+443		95+734	700	50	1V/2H
Sabine Bank Channel	95+734		25+800	700	50	1V/2H
Sabine Bank Channel	25+800		23+300	800–700	50	1V/2H
Sabine Bank Channel	23+300		18+000	800	50	1V/2H
Sabine Pass Outer Bar	18+000		0+000	800	50	1V/10H
Sabine Pass Jetty Channel	–214+88		0+00	800–500	48	1V/2H
Sabine Pass Channel	0+00		296+25	1,355–500	48	1V/2H
Port Arthur Canal	0+00		325+84	1,660–500	48	1V/2H
Sabine-Neches Canal	0+00		592+94	1,050–400	48	1V/2H
Neches River Channel	0+00		980+00	400–1,413	48	1V/2H
Taylor Bayou						
Entrance Channel	0+00		25+27	406–764	48	1V/2H
East Turning Basin	0+00		17+65	532–354	48	1V/2H
West Turning Basin	25+27		41+30	776	48	1V/2H
Connecting Channel	41+30		71+50	470–250	48	1V/2H
Taylor Bayou Turning Basin	71+50		106+25	1,000	48	1V/2H

*Vertical to horizontal distance.

The authorized depth of the channel in the Preferred Alternative would increase from 40 to 48 feet along the entire existing channel, and the offshore entrance channel would extend 13.2 miles farther into the Gulf. The Sabine Pass Jetty Channel, Sabine Pass Channel, Port Arthur and Sabine-Neches canals, and the Neches River Channel would be deepened from 40 to 48 feet. The authorized depth of the existing offshore Entrance Channel (Sabine Pass Outer Bar Channel and Sabine Bank Channel) is currently 42 feet; the additional depth is needed to accommodate fluctuations in offshore surface water elevation. These channels and the proposed Sabine Bank Extension Channel would be deepened from 42 to 50 feet.

This would increase the SNWW from 64 miles to approximately 77 miles in length. No modifications to the existing Sabine Pass Jetties would be required as part of the CIP.

The Sabine Pass Jetty Channel and the majority of the inshore channels (Sabine Pass Channel, Port Arthur Canal, Sabine-Neches Canal, and Neches River Channel) would remain at their existing widths. With the exception of wider sections at anchorages or channel intersections, these channels transition from 500 feet wide between the jetties to 400 feet wide upstream of the Martin Luther King (MLK) Bridge on the Sabine-Neches Canal and Neches River Channel. The Taylor Bayou Channels and Basins would also be widened and deepened to 48 feet. Although the Sabine-Neches Canal and Neches River

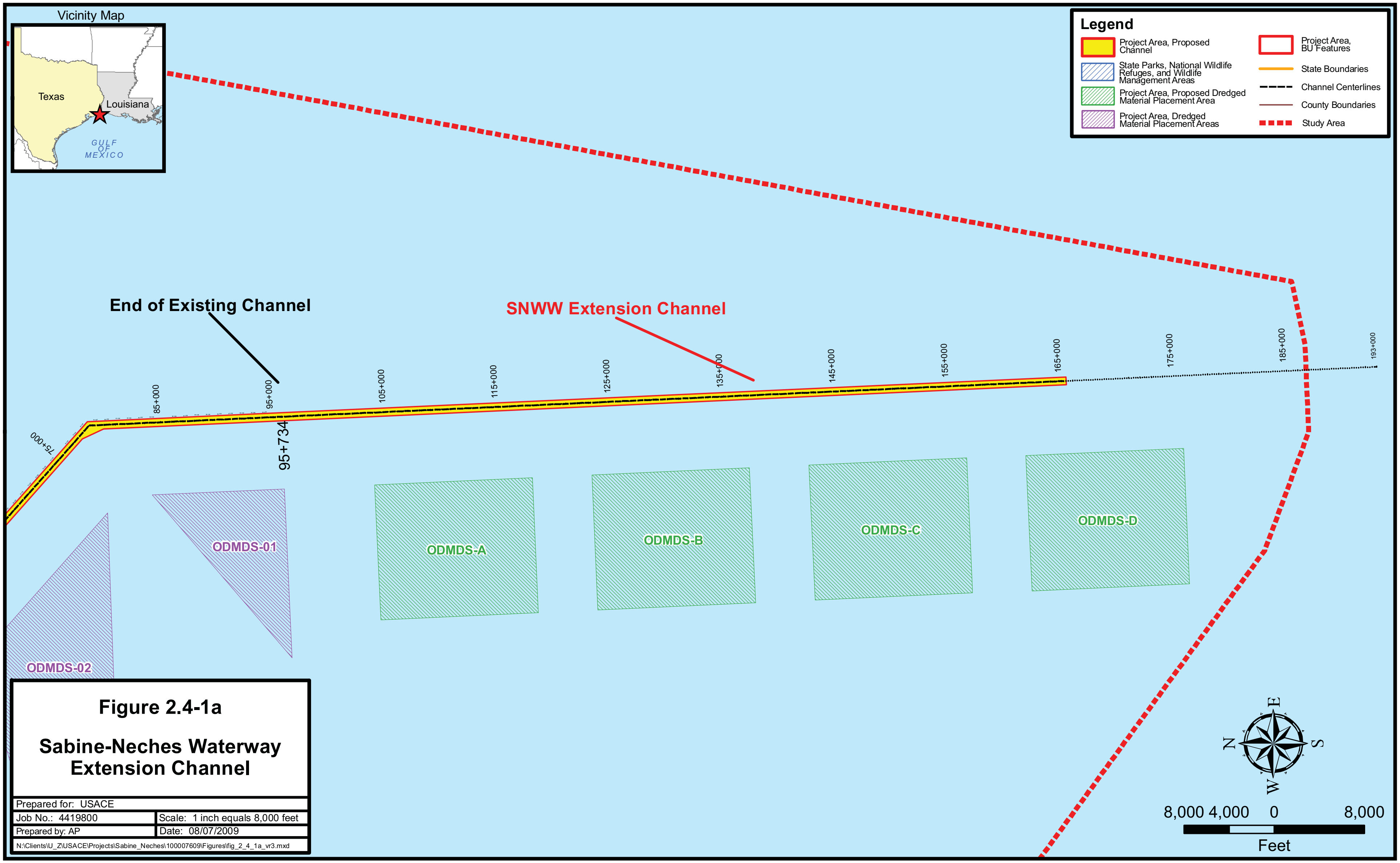

Figure 2.4-1a

Sabine-Neches Waterway Extension Channel

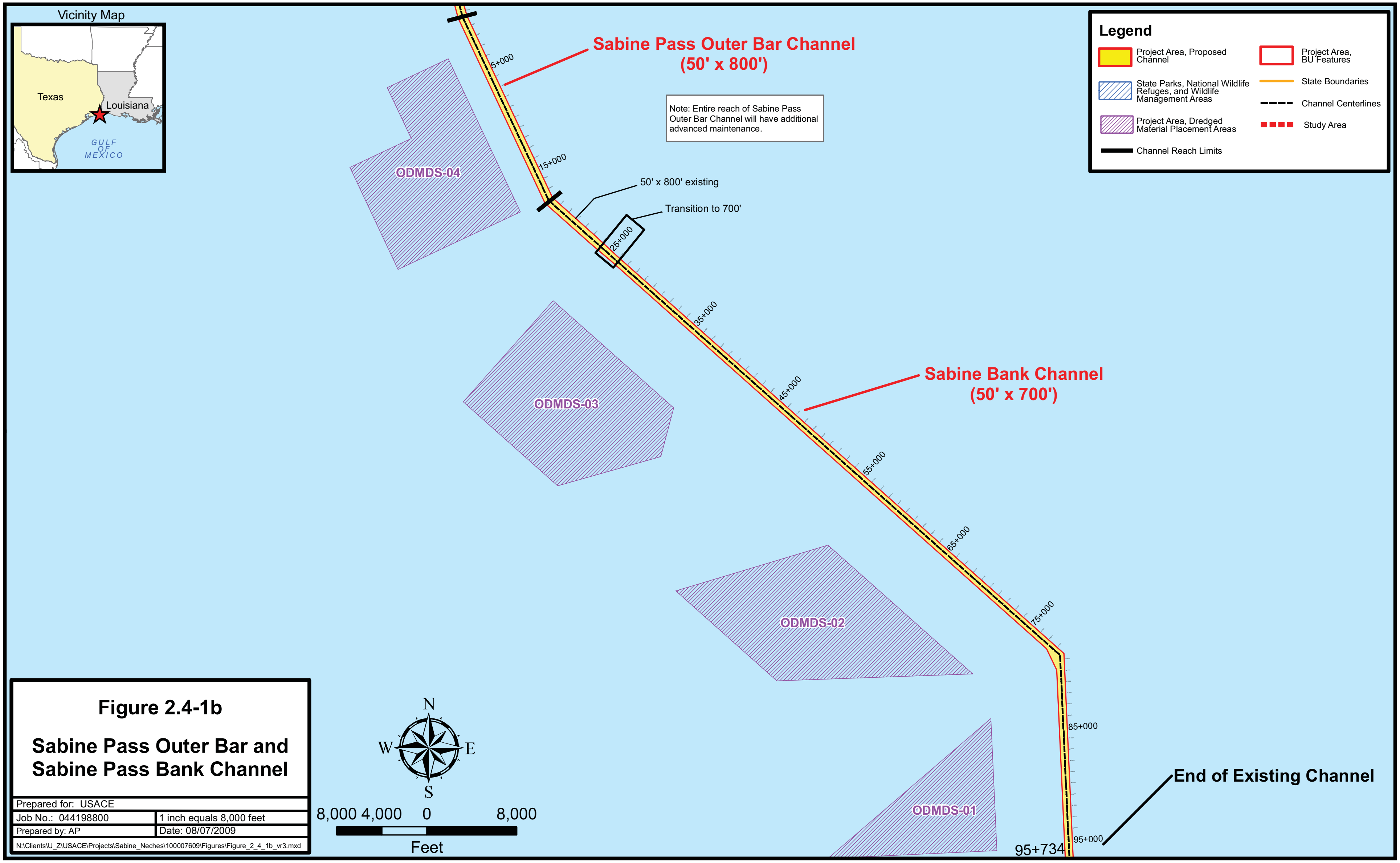

Figure 2.4-1b

Sabine Pass Outer Bar and Sabine Pass Bank Channel

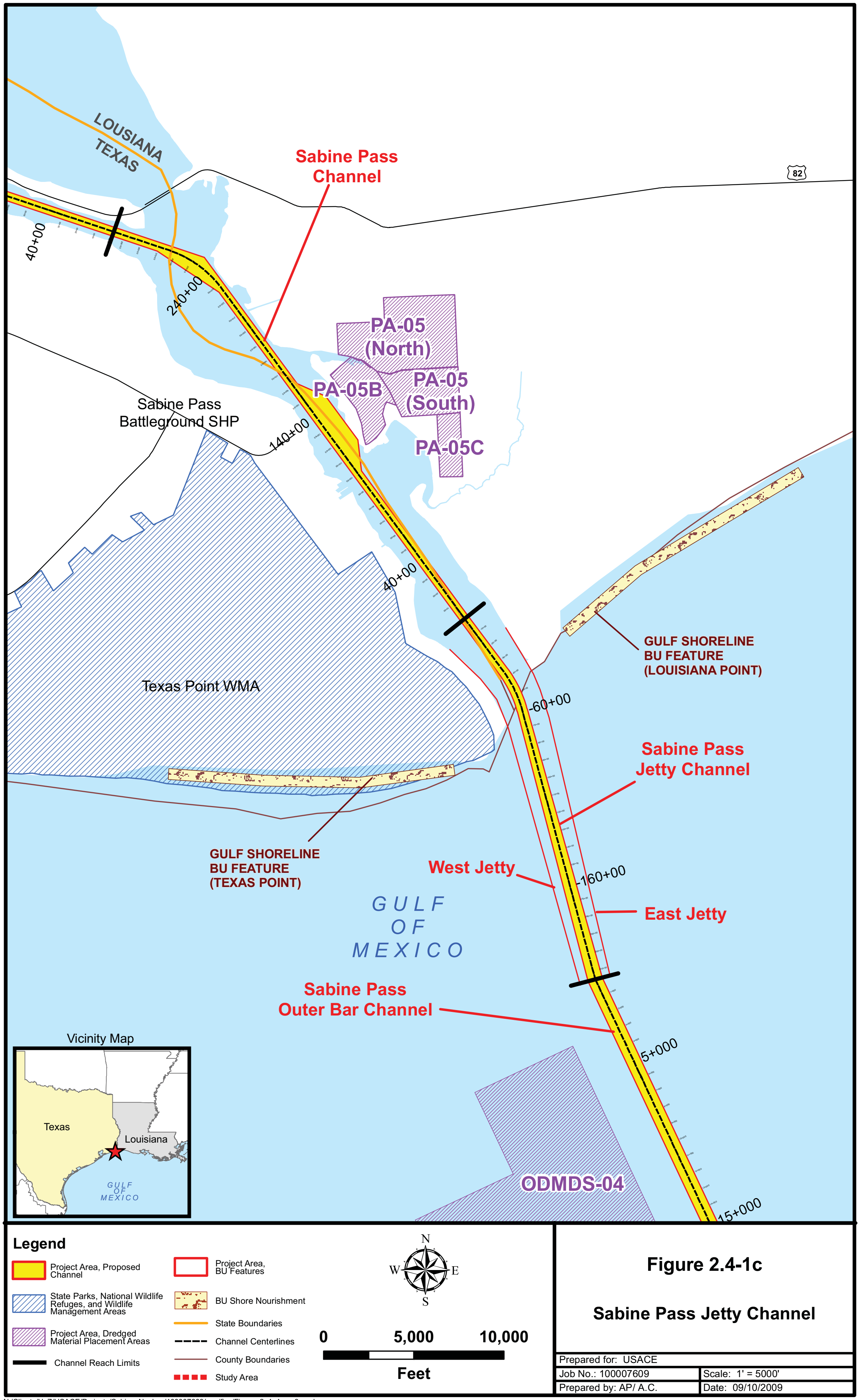

Figure 2.4-1c

Sabine Pass Jetty Channel

Prepared for: USACE	
Job No.: 100007609	Scale: 1' = 5000'
Prepared by: AP/ A.C.	Date: 09/10/2009

N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/geo/figs/Figure_2_4_1c_vr3.mxd

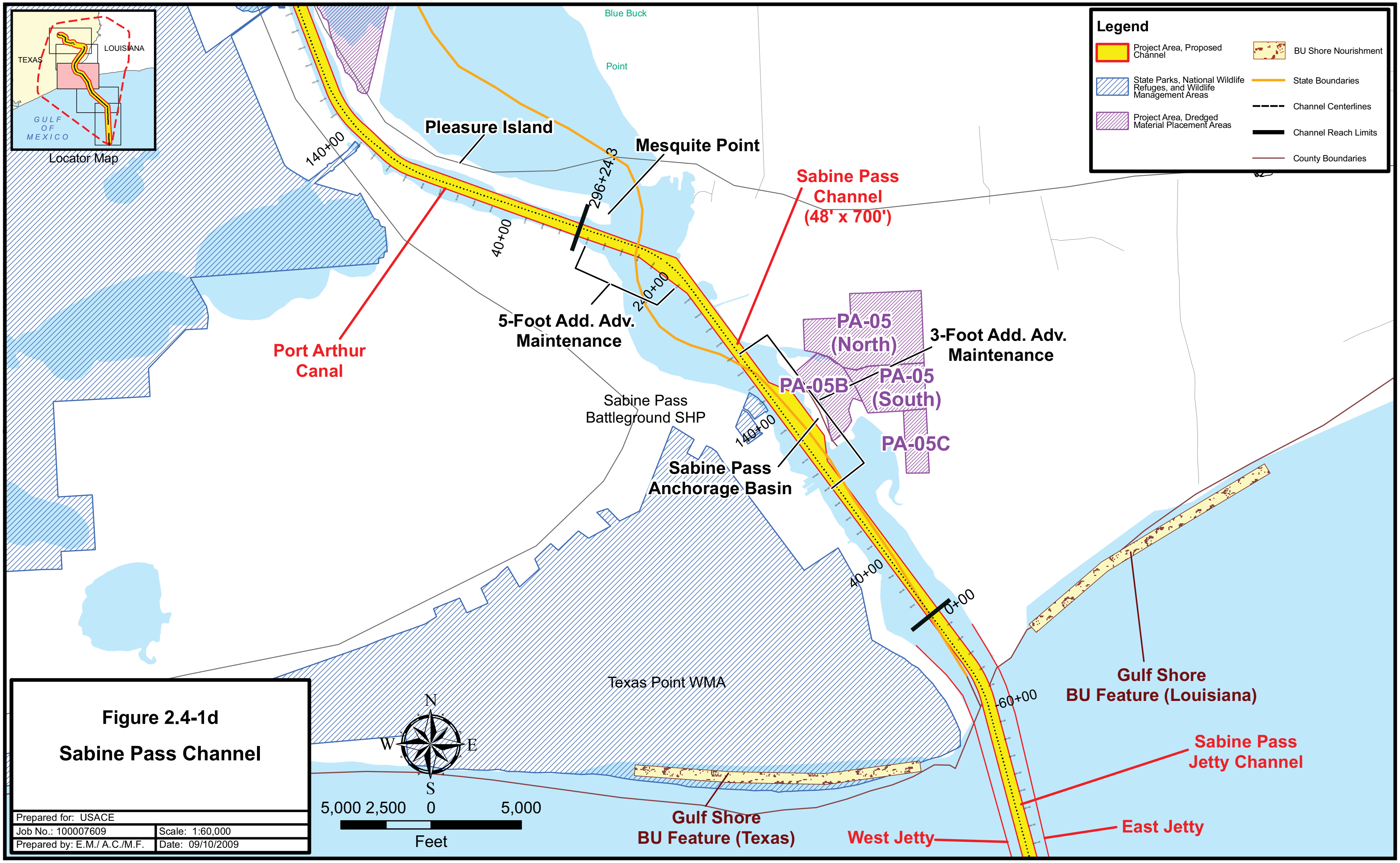

Figure 2.4-1d

Sabine Pass Channel

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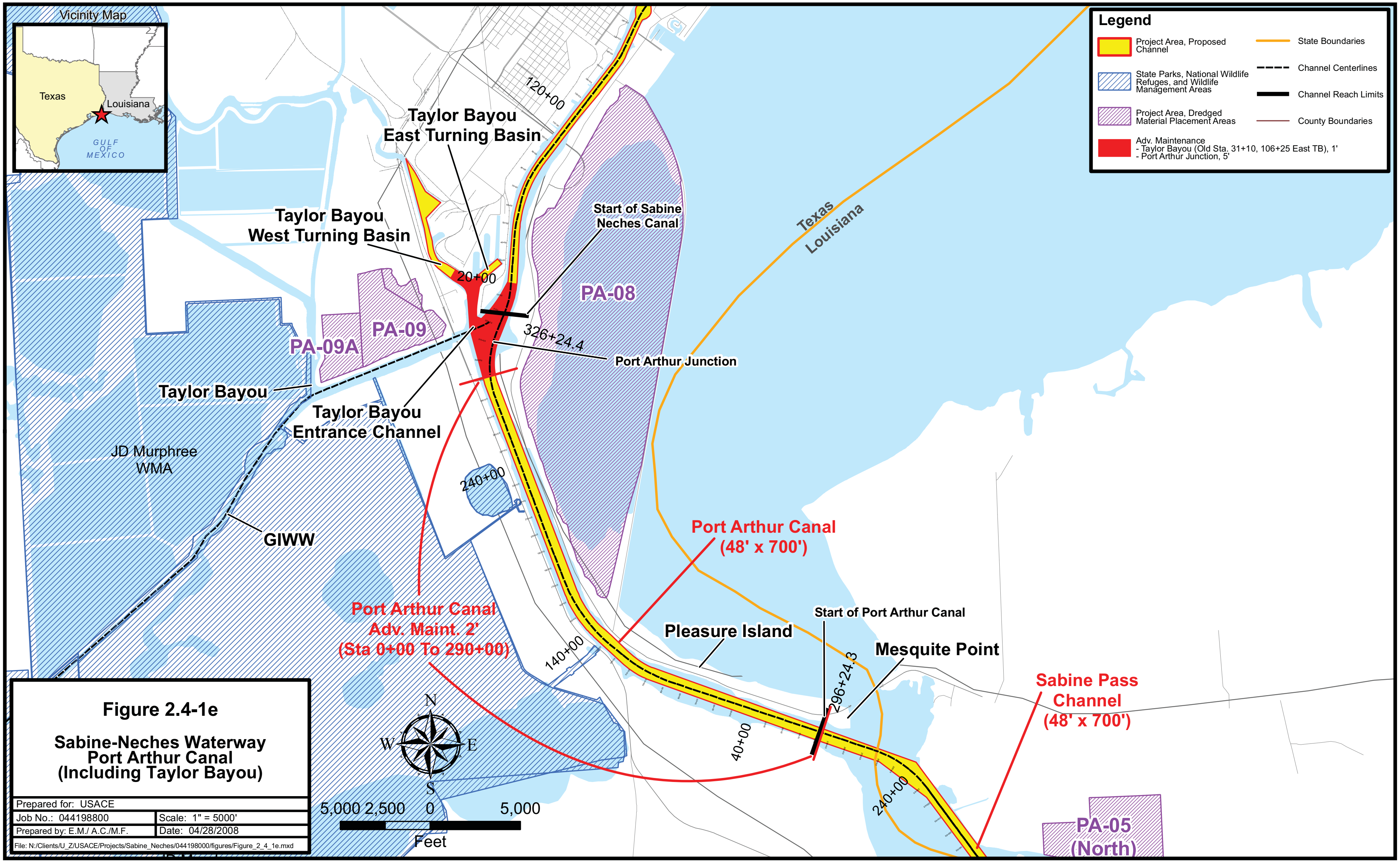


Figure 2.4-1e

Sabine-Neches Waterway
Port Arthur Canal
(Including Taylor Bayou)

Prepared for: USACE	
Job No.: 044198800	Scale: 1" = 5000'
Prepared by: E.M./ A.C./M.F.	Date: 04/28/2008

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/044198000/figures/Figure_2_4_1e.mxd

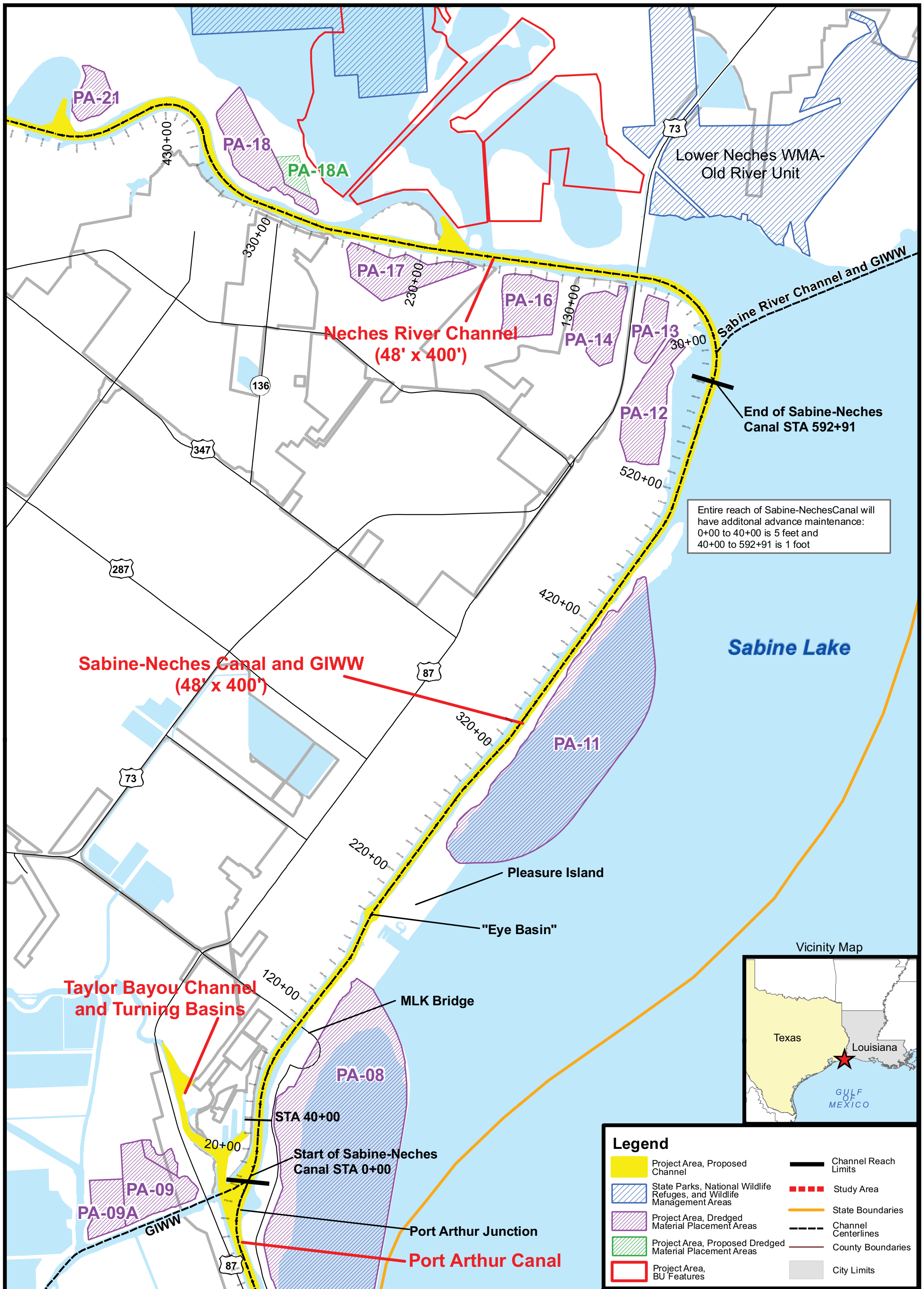


Figure 2.4-1f

Sabine-Neches Waterway
Sabine-Neches Canal

Prepared for: USACE	
Job No.: 100007609	Scale: 1" = 6000'
Prepared by: RF	Date: 1 April 2010

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/figures/Figure_2_4_1f_vr4.mxd

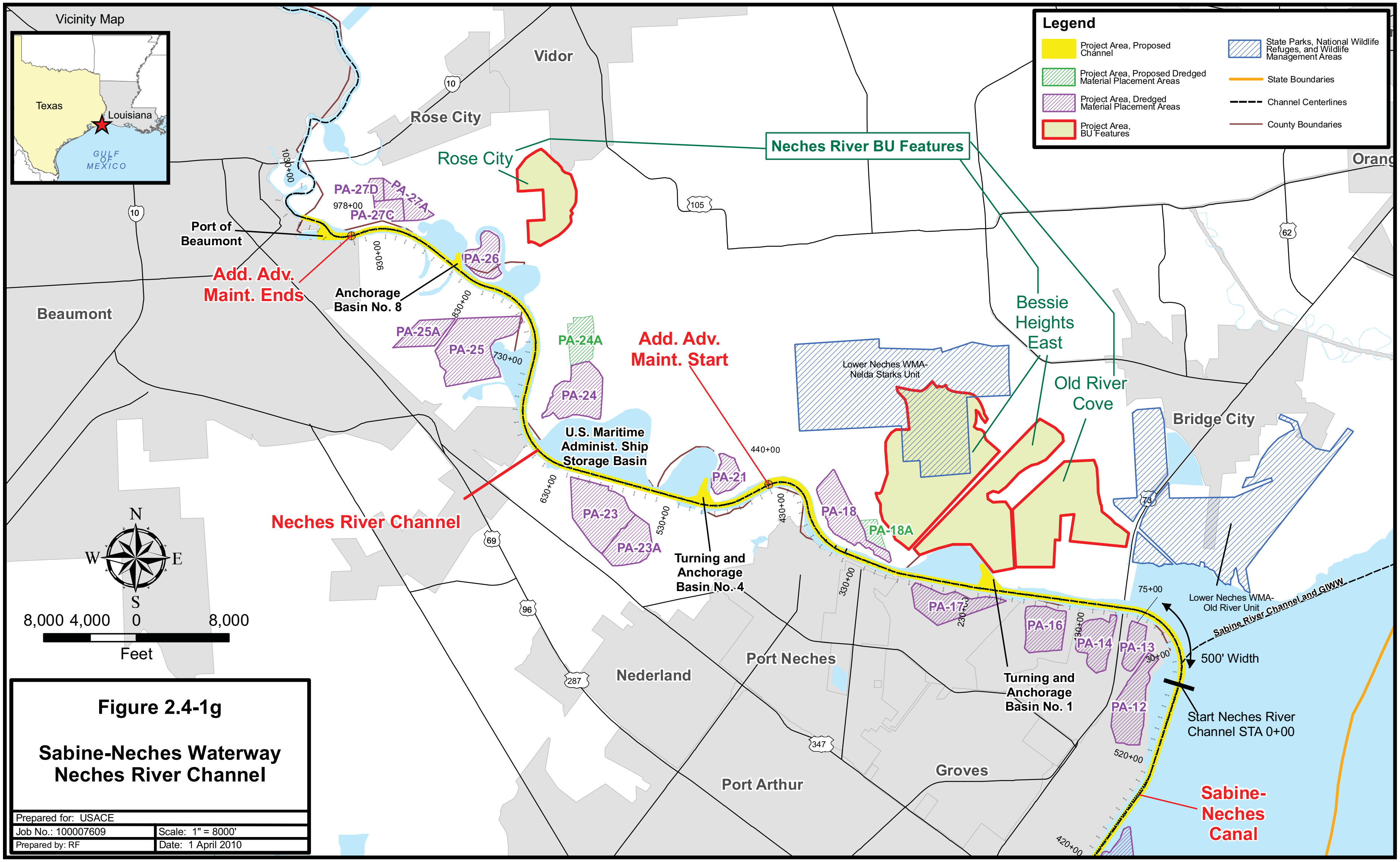


Figure 2.4-1g

Sabine-Neches Waterway
Neches River Channel

Prepared for: USACE	
Job No.: 100007609	Scale: 1" = 8000'
Prepared by: RF	Date: 1 April 2010

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Figure_2_4_1g_vr3.mxd

Channel would not be widened, navigation efficiency would be improved with short stretches of selective widening and bend easings in both reaches, and the addition or enlargement of one anchorage and two turning/anchorage basins on the Neches River Channel.

The Preferred Alternative would generate an estimated 98 mcy of new work and 650 mcy of maintenance material over the 50-year period of analysis (Table 2.4-2). The annual maintenance dredging quantities in the SNWW will increase from an average of 8.1 mcy for the current 40-foot project to 13.0 mcy for the proposed 48-foot project.

Table 2.4-2
New Work and 50-Year Maintenance Quantities for Preferred Alternative

	Channel Reach	New Work Quantities (cy)	50-Year Maintenance Quantities (cy)
Offshore	Sabine Bank Extension	18,737,000	36,216,000
	Sabine Bank Channel	15,358,000	96,371,000
	Sabine Pass Outer Bar Channel	5,923,000	223,650,000
	Sabine Pass Jetty Channel	2,978,000	13,527,000
Inshore	Sabine Pass Channel	6,723,000	34,781,000
	Port Arthur Canal*	11,697,000	82,858,000
	Sabine-Neches Canal	11,944,000	73,245,000
	Neches River Channel	25,014,000	89,725,000
	Total Quantities	98 mcy	650 mcy

*Includes Taylor Bayou channels and basins.
cy = cubic yards

Dredging depths will actually be deeper than the authorized depth when allowances for overdepth and advanced maintenance are included. Allowable overdepth is an additional depth outside the required dredging template that is permitted to allow for inaccuracies in the dredging process. Allowable overdepth for the existing channel varies between 1 and 2 feet. The Preferred Alternative would maintain a constant 2 feet of allowable overdepth for all channel reaches. Advance maintenance is the practice of dredging deeper than the authorized channel dimensions to provide for the accumulation and storage of sediment. In critical and fast-shoaling areas, it is required to avoid frequent redredging and to ensure the reliability and least overall cost for operating and maintaining the project authorized dimensions. The existing SNWW project has a constant 2-foot advance maintenance depth, and the Preferred Alternative assumes a minimum 2-foot depth for all channel reaches. During the Final Alternatives evaluation phase, an analysis was performed to identify potential with-project changes in dredging frequencies, and to determine whether an increase in advance maintenance would be required. As a result, an increase in advance maintenance (ranging from 1 to 5 feet) was proposed for some portions of some channel reaches to allow the proposed dredging frequency to remain the same as the existing O&M dredging frequency. The full potential dredging depth is provided in the description for each reach below. The full potential depths of each channel reach (including allowable overdepth, advance maintenance, and additional advance maintenance) were included in the HS modeling. Each channel reach is divided into different sections for dredging contracts. These sections are shown on the Engineering Plates in the FFR.

2.4.1.1 Sabine Bank Extension Channel

This channel would lengthen the existing offshore entrance channel approximately 13.2 miles at a bottom width of 700 feet (Figure 2.4-1a). The additional length is required to reach a water depth in the Gulf equal to the proposed channel depth. The proposed offshore depth is 50 feet, but advance maintenance and allowable overdepth would add a total of 4 more feet, bringing the total dredged depth of the Extension Channel to 54 feet. It would be constructed by hopper dredge beginning at the end of the Sabine Bank Channel, and it would extend into the Gulf at the same bearing as the Sabine Bank Channel. An overview of the project details for the Sabine Bank Extension is listed in Table 2.4-3.

Table 2.4-3
Project Details of Sabine Bank Extension

Length of Reach	13.2 miles (new)
Project Depth	50 feet
Bottom Width	700 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
New Work Material	18,737,000 cy
Placement Areas	ODMDSs A, B, C, and D
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	36,216,000 cy
Increase in Maintenance Material	36,216,000 cy
Placement Areas	ODMDSs A, B, C, and D
Beneficial Use of Dredged Material	None

2.4.1.2 Sabine Bank Channel

This 14.7-mile-long channel would be deepened from 42 to 50 feet using a hopper dredge (Figure 2.4-1b). When advance maintenance and allowable overdepth are added to the proposed 50-foot depth, the Sabine Bank Channel would be dredged to 54 feet. The bottom width of the Sabine Bank Channel is currently 800 feet; it would remain 800 feet wide for the first mile past the end of the Outer Bar Channel, and then it would taper from 800 feet to 700 feet over the next 0.5 mile. The Sabine Bank Channel would continue the 700-foot bottom width for approximately 13.2 miles to its connection with the Extension Channel. Since the existing channel is 800 feet wide, new channel markers would be required to mark the tapered transition and the remainder of the narrowed Sabine Bank Channel. An overview of the project details for the Sabine Bank Channel reach is listed in Table 2.4-4.

Table 2.4-4
Project Details for Sabine Bank Channel Reach

Length of Reach (sections 1, 2)	14.7 miles (no change)
Project Depth	50 feet
Bottom Width	800 feet then narrow to 700 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
New Work Material	15,358,000 cy
Placement Areas	ODMDSs 1 and 2
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	96,371,000 cy
Increase in Maintenance Material	45,549,000 cy
Placement Areas	ODMDSs 1 and 2
Beneficial Use of Dredged Material	None

2.4.1.3 Sabine Pass Outer Bar Channel

This 3.4-mile-long channel would be deepened from 42 to 50 feet using a hopper dredge (see Figure 2.4-1b). This portion of the channel has higher-velocity eddies moving around the end of the east jetty, which causes sediment to settle out as the currents cross the navigation channel, creating a higher shoaling rate. Due to the high shoaling rate, advance maintenance amounts would be increased to maintain current maintenance dredging cycles. When advance maintenance and allowable overdepth are added, the Outer Bar Channel could be dredged to 58 feet. The Outer Bar Channel would remain at its current 800-foot bottom width due to strong crosscurrents just beyond the end of the jetties. An overview of the project details for the Sabine Pass Outer Bar Channel reach is listed in Table 2.4-5.

Table 2.4-5
Project Details for Sabine Pass Outer Bar Channel Reach

Length of Reach (Section 3)	3.4 miles (no change)
Project Depth	50 feet
Bottom Width	800 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
Additional Advance Maintenance	4 feet
New Work Material	5,923,000 cy
Placement Areas	ODMDS 3
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	223,650,000 cy
Increase in Maintenance Material	123,965,000 cy
Placement Areas	ODMDS 3
Beneficial Use of Dredged Material	None

2.4.1.4 Sabine Pass Jetty Channel

This 4.1-mile-long channel would be deepened to 48 feet using a hopper dredge (Figure 2.4-1c). When advance maintenance and allowable overdepth are added, the Sabine Pass Jetty Channel could be dredged to 52 feet. The channel would gradually taper from the existing 800-foot width at the jetties' mouth to the existing 500-foot width. No impacts to the jetties would be associated with the proposed improvements. An overview of the project details for the Sabine Pass Jetty Channel reach is listed in Table 2.4-6.

Table 2.4-6
Project Details for Sabine Pass Jetty Channel Reach

Length of Reach (Section 4)	4.1 miles (no change)
Project Depth	48 feet
Bottom Width	800 to 500 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
New Work Material	2,978,000 cy
Placement Areas	ODMDS 4
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	13,527,000 cy
Increase in Maintenance Material	2,142,000 cy
Placement Areas	ODMDS 4
Beneficial Use of Dredged Material	None

2.4.1.5 Sabine Pass Channel

This 5.6-mile-long channel begins just north of the jetties and extends upstream to Mesquite Point on Pleasure Island (Figure 2.4-1d). It would be deepened to 48 feet and constructed with a hydraulic pipeline dredge. Advance maintenance would vary in different sections of the Sabine Pass Channel to account for differences in shoaling rates. The maximum dredging depth for two reaches of this channel (Station 0+00 to Station 100+00, and Station 180+00 to Station 230+00) would be 52 feet. Due to additional advance maintenance required to maintain existing O&M dredging cycles, the reaches from Station 100+00 to Station 180+00 and Station 230+00 to the end of the Sabine Pass Channel at 296+25 would be dredged to a depth of 55 feet. The bottom width of the Sabine Pass Channel would remain 500 feet. The Sabine Pass Anchorage is located in this reach and its footprint would be reduced in size because it has never been fully utilized. The width would be decreased from 1,500 feet to 855 feet, and the length remains 8,200 feet. The angle of approach would remain the same. An overview of the project details for the Sabine Pass Channel reach is listed in Table 2.4-7.

2.4.1.6 Port Arthur Canal (including Taylor Bayou Channels and Turning Basins)

This 6.2-mile-long canal begins near Mesquite Point and ends at the Port Arthur Junction Area with the Taylor Bayou channels (Figure 2.4-1e). The Junction Area serves as a turning basin and has an irregular shape where the Taylor Bayou channels and the GIWW merge with it. The Port Arthur Canal would be deepened to the proposed depth of 48 feet with a hydraulic pipeline dredge. Advance maintenance would vary in different sections of the Port Arthur Canal to account for differences in shoaling rates. The reach from Station 00+00 to Station 290+00 would be dredged to a maximum depth of 53 feet. The remaining part (Port Arthur Junction) between Stations 290+00 and 325+84 would be dredged to a maximum depth of 57 feet. The bottom width of the Port Arthur Canal would remain 500 feet up to the Junction Area. An overview of the project details for the Port Arthur Canal reach (including Taylor Bayou) is listed in Table 2.4-8.

Table 2.4-7
Project Details for Sabine Pass Channel Reach

Length of Reach (sections 5 and 6)	5.6 miles (no change)
Project Depth	48 feet
Bottom Width	500 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
Additional Advance Maintenance	Station 100+00 to Station 180+00 is 3 feet Station 230+00 to Station 295+61 is 3 feet
New Work Material	6,723,000 cy
Placement Areas	PA 5
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	34,781,000 cy
Increase in Maintenance Material	4,191,000 cy
Placement Areas	none
Beneficial Use of Dredged Material	Gulf Shore Beneficial Use Feature

Table 2.4-8
Project Details for Port Arthur Canal Reach (including Taylor Bayou)

Length of Reach (sections 7 and 8)	6.2 miles (no change)
Project Depth	48 feet
Bottom Width	Varies (widest is 500 feet)
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
Additional Advance Maintenance	(PA Canal) Station 0+00 to 290+00 is 1 foot (PA Canal) Station 290+00 to 326+37 is 5 feet (Taylor Bayou) Station 0+00 to 31+00 is 5 feet (Taylor Bayou) Station 31+00 to 106+25 is 1 foot
New Work Material	11,697,000 cy
Placement Areas	PAs 8 and 9
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	82,858,000 cy
Increase in Maintenance Material	5,391,000 cy
Placement Areas	PA 8 and 9
Beneficial Use of Dredged Material	None

Located at the confluence of the Port Arthur Junction Area, the GIWW, and the mouth of the original Taylor Bayou, the Taylor Bayou Channels and Turning Basins consist of several sub-reaches: Entrance Channel, East Turning Basin, West Turning Basin, Connecting Channel, and the Taylor Bayou Turning Basin. Several significant changes are proposed for this area. When advance maintenance and allowable overdepth are added to the proposed 48-foot depth, all of the Taylor Bayou Channels and Basins could be dredged to 53 feet. The Taylor Bayou portion of the Junction Area, between Taylor Bayou Stations 0+00 and 41+20, would be dredged to 57 feet. The Taylor Bayou Entrance Channel and the West Turning Basin bottleneck curve would be widened, and a structural wall would protect local railroad tracks. Changes for each sub-reach are detailed below.

- **Taylor Bayou Entrance Channel.** The new bottom width widens on the west side of the channel. The channel would be widened to 444 feet at new Station 10+00. The new bottom width would taper back to the existing width by the end of the first curve at Station 28+38.
- **East Turning Basin.** The right side width would decrease 16 feet as the new depth extends down the existing side slope.
- **West Turning Basin.** The width of the existing bottleneck has been increased up to 120 feet on the west side, between new stations 33+00 and 55+00. The west bank of the basin would be protected by a structural wall, preventing impacts to the local railroad tracks present in this area.
- **Connecting Channel.** The West Turning Basin widening would taper back to the existing width in the Connecting Channel, between stations 55+00 and 67+00.
- **Taylor Bayou Turning Basin.** No changes would be made to the existing dimensions, but the basin would be deepened to the proposed 48-foot depth. Existing shore protection belonging to a local facility near Station 90+00 would be affected by penetration by the top-of-cut for the new depth.

2.4.1.7 Sabine-Neches Canal

The 11.2-mile-long canal begins at the Port Arthur Junction Area and ends just south of the mouth of the Neches River (Figure 2.4-1f). The GIWW shares this canal with the deep-draft channel. It would be deepened to the proposed depth of 48 feet with a hydraulic pipeline dredge. When advance maintenance and allowable overdepth are added, stations 0+00 to 40+00 could be dredged to 57 feet, and the remainder of the canal through Station 592+91 could be dredged to 53 feet.

The bottom width of this canal would be selectively widened in three separate sections. The bottom width of the most-downstream curve (stations 0+00 to 20+00) would be widened to 500 feet on the east side of the channel, and then promptly tapered to the existing 400-foot width prior to the MLK Bridge (SH 82). The canal would be widened to 450 feet adjacent to the Port of Port Arthur, with gradual tapering upstream and downstream between stations 120+00 and 170+00. The third widening section would begin to taper at Station 565+00, gradually widening to 500 feet and remaining that width to the end at Station 592+91.

Bend easing is proposed for three areas in the Sabine-Neches Canal to improve ship maneuverability: stations 265+00 to 305+00, stations 350+00 to 395+00, and stations 500+00 to 520+00. The bend easing between stations 350+00 to 395+00 would eliminate a wiggle in the alignment and shift the footprint of the canal 10 feet east of the existing alignment up to Station 520+00.

Changes are also recommended for the canal bottom adjacent to the Port Arthur Dock and the "Eye Basin." The canal toes adjacent to the Port of Port Arthur would be moved approximately 10 feet to the east while keeping the same bottom width of 450 feet. The diameter of the turning point ("Eye Basin") at Station 190+00 would be decreased by 16 feet. An overview of the project details for the Sabine-Neches Canal reach is listed in Table 2.4-9.

Table 2.4-9
Project Details for Sabine-Neches Canal Reach

Length of Reach (sections 9 and 10)	11.2 miles (no change)
Project Depth	48 feet
Bottom Width	varies 400 to 500 feet
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
Additional Advance Maintenance	Station 0+00 to 40+00 is 5 feet Station 40+00 to 592+91 is 1 foot
New Work Material	11,944,000 cy
Placement Areas	PA 11
Beneficial Use of Dredged Material	None
Maintenance Material (50-year quantity)	73,245,000 cy
Increase in Maintenance Material	13,122,000 cy
Placement Areas	PAs 8 and 11
Beneficial Use of Dredged Material	None

2.4.1.8 Neches River Channel

This 18.5-mile-long channel begins just south of the mouth of the Neches River (Figure 2.4-1g). It would be deepened to the proposed depth of 48 feet to Station 980+00 with a hydraulic pipeline dredge. Advance maintenance would vary in different sections of the Neches River Channel to account for differences in shoaling rates. Between stations 0+00 and 440+00, the maximum dredged depth would be 52 feet; between stations 440+00 and 978+00, it would be 54 feet. While the overall bottom width of 400 feet does not change for the majority of the channel length, the first curve at the mouth of Neches River (between stations 0+00 and 75+00) would be widened to 500 feet, and then tapered back to 400 feet prior to the SH 87 twin bridges. The channel also will be widened to 500 feet between turning basins No. 1 and No. 2. An overview of the project details for the Neches River Channel reach is listed in Table 2.4-10.

Three basins will be added or enlarged on the Neches River Channel. All would be dredged to the proposed depth of 48 feet, plus the advance maintenance and allowable overdepth associated with the specific channel reach in which they are located.

Table 2.4-10
Project Details for the Neches River Channel Reach

Length of Reach (sections 11–18)	18.5 miles (no change)
Project Depth	48 feet
Bottom Width	400 feet (majority of channel) 500 feet Station 0+00 to 75+00
Advance Maintenance	2 feet
Allowable Overdepth	2 feet
Additional Advance Maintenance	Station 440+00 to 978+00 is 2 feet
New Work Material	25,014,000 cy
Placement Areas	PAs 12, 13, 14, 16, 18, 21, 23, 24, 25, 26, 27
Beneficial Use of Dredged Material	Neches River BU Feature
Maintenance Material (50-year quantity)	89,725,000 cy
Increase in Maintenance Material	23,277,000 cy
Placement Areas	PAs 12, 13, 14, 16, 17, 18, 21, 23, 24, 25, 26, 27
Beneficial Use of Dredged Material	Neches River BU Feature (Rose City East and Bessie Heights East only)
Turning Basins/Anchorage Areas	1 New; 2 Enlarged; 5 No change

- Turning and Anchorage Basin No. 1 would be located in an old river oxbow at the east end of Texaco Island near Station 210+00. The Turning Basin would enlarge the existing basin from 1,000 to 1,350 feet in diameter. A new Anchorage Basin, 250 by 1,100 feet in size, would be added.
- Turning and Anchorage Basin No. 4 would enlarge an existing turning point at Station 510+00 from 1,000 to 1,350 feet in diameter. A new Anchorage Basin in the old river oxbow at Station 500+00 would be 250 by 1,100 feet in size.
- Turning Basin No. 6 is an existing basin at Station 700+00. It would retain the same dimensions and would not be deepened to the proposed depth of 48 feet. Maintenance dredging would continue at the existing depth.
- The new Anchorage Basin No. 8 would be located at Station 850+00. The 250-x-1,000-foot basin is located in an old river oxbow.
- The Beaumont Maneuvering Basin's overall dimensions would remain the same as the existing project. Located near Station 975+00, it would be deepened to the proposed 48-foot depth.

2.4.1.9 Bridge Reinforcements and Fenders

Deepening and selective widening improvements to the SNWW navigation channels would affect existing fender systems of the Rainbow Bridge and Veterans Memorial Bridge over the Neches River Channel on SH 87 and the MLK Bridge over the Sabine-Neches Canal on SH 82. Bridge fender systems on both sides of the channel would require removal and replacement. None of the bridges would cause an unreasonable obstruction to navigation, and thus would not require modification or replacement pursuant to the Truman-Hobbs Act. However, existing MLK Bridge piers would be armored to protect them from erosion and maintain the proposed 400-foot channel width.

2.4.1.10 Aids to Navigation

Many of the existing aids to navigation within the waterway would require removal and replacement. The upstream reach from the Beaumont Maneuvering Basin and the vicinity of SH 87 on the Neches River Channel would not require changes in the navigation aids. Ranges and buoys would not need to be replaced along the Port Arthur Canal, Sabine Pass Channel, and Sabine Pass Jetty Channel. However, aids along the remainder of the waterway would need to be relocated, and new aids will be required along the Extension Channel.

2.4.1.11 Lands, Easements and Rights-of-Way

The non-Federal Sponsor is required to furnish the LERR for the proposed cost-shared project. The real estate requirements must support construction as well as operation and maintenance of the project after completion. A summary of the real estate requirements for each channel reach is provided in Table 2.4-11. Specific details of the real estate requirements can be found in the Real Estate Plan, Appendix 3 of the FFR.

Table 2.4-11
Real Estate Requirements for Placement Areas

	Real Estate Requirement
Channel Reach	
Sabine Bank Extension	Navigational servitude
Sabine Bank Channel	Navigational servitude
Sabine Pass Outer Bar Channel	Navigational servitude
Sabine Pass Jetty Channel	Navigational servitude
Sabine Pass Channel	Acquire in Fee (PA 5)
Port Arthur Canal	Navigational servitude (PA 8) Acquire in Fee (PA 9)
Sabine-Neches Canal	Navigational servitude (PAs 8, 11)
Neches River Channel	Owned by Sponsor (No-Action) (PAs 12, 13, 14, 16, 18, 18A, 21, 23, 23A, 24, 24A, 25, 25A) Acquire in Fee (PAs 17, 26, 27A, 27C, 27D) Turning Basins – two will require the acquisition of land in perpetual channel improvement easement
Louisiana Mitigation Areas	
Willow and Black Bayou Areas	Navigational servitude

2.4.1.12 Relocations

The following assumptions were made to identify pipelines that could be affected by the recommended plan and to develop associated costs. The individual circumstances of each pipeline will be evaluated by USACE in consultation with non-Federal sponsor and the pipeline owner during the preconstruction, engineering, and design (PED) and Construction phases, and decisions regarding necessary actions will be made individually for each pipeline at that time. Feasibility engineering guidelines indicate that pipelines with a minimum of 8 feet of cover for trenched lines or 5 feet of cover for directionally drilled lines would not be adjusted. Pipelines that do not meet the minimum cover requirement would be required to be adjusted.

The adjusted pipelines must be located 20 feet below the authorized 48-foot depth. The 20 feet includes any advance maintenance and allowable overdepth. The relocation of active pipelines is assumed to be installed with directional drilling, and bundled where possible.

A total of 104 pipelines have been identified crossing the SNWW navigation channels. Of the 104 pipelines, 46 require adjustment to meet the minimum required vertical and horizontal clearances for the SNWW CIP.

Pursuant to Section 101(a) of the Water Resources Development Act (WRDA) of 1986, as amended, the Sponsor is responsible for performing, or assuring performance, of all relocations, including utility relocations, which are necessary for the CIP. All relocations, including utility relocations, are to be accomplished at no cost to the Federal Government.

The USACE, Galveston District has concluded preliminarily that 41 of the 46 lines located within the channel must be relocated and are classified as utility relocations for which the Sponsor must perform or assure performance. In accordance with Section 101(a)(4) of WRDA 86, one-half of the cost of each such relocation will be borne by the owner of the facility being relocated and one-half of the cost of each such relocation will be borne by the Sponsor. Such relocation costs will not include any cost for upgrading or improving such facilities, which is to be borne by the facility owner.

For more specific information regarding the utility relocations, and preliminary conclusions regarding the remaining 5 lines that must be removed but not replaced, see the FFR, Real Estate Plan, Appendix 4.

DMMP marsh restoration at Bessie Heights and mitigation marsh restoration measures east of Sabine Lake were assumed to require no relocations. However, since oil production is active in some of these areas, additional pipeline searches and coordination with pipeline owners would be required prior to construction to avoid impacts.

No relocations would be required for overhead power utilities, highway bridges, the Port Arthur Hurricane Flood Protection Levee, or its associated pump stations and closure structures.

2.4.2 Dredged Material Placement Areas

Dredged material produced by construction and operation of the Preferred Alternative over the 50-year period of analysis would be managed in accordance with the DMMP. More details can be found in the DMMP presented in Appendix D of this FEIS. The total new work construction quantity was presented in Table 2.4-2. Information on proposed maintenance quantities is important in evaluating potential project impacts. Table 2.4-12 provides a reach-by-reach comparison of maintenance quantities for the existing project (No-Action Alternative) and the Preferred Alternative. Disposal features proposed for the

Preferred Alternative consist of beneficial use features, upland PA features, and ODMDSs. The location of all disposal features is shown on Figures 2.4-1a–g.

Table 2.4-12
Existing and Proposed Maintenance Dredging Quantities

Channel Reach	Existing 50-Year Maintenance Quantities (cy)	Proposed 50-Year Maintenance Quantities (cy)
Sabine Bank Extension	0	36,216,000
Sabine Bank Channel	50,822,000	96,371,000
Sabine Pass Outer Bar Channel	99,685,000	223,650,000
Sabine Pass Jetty Channel	11,385,000	13,527,000
Sabine Pass Channel	30,590,000	34,781,000
Port Arthur Canal	88,249,000	82,858,000
Sabine-Neches Canal	60,123,000	73,245,000
Neches River Channel	66,448,000	89,725,000
Total Quantities	407 mcy	650 mcy

2.4.2.1 Quantities and Types of Dredged Material

Construction of the Preferred Alternative would require the development of significantly more PA capacity than currently exists for the SNWW project. The existing project uses 16 upland PAs and 4 ODMDSs. Construction of the Preferred Alternative would generate 98 mcy of new work material. Shoaling is projected to increase with the Preferred Alternative for several reasons (Parchure et al., 2005). The Entrance Channel would extend an additional 13.2 miles into the Gulf, and this would result in higher offshore dredging quantities. The deeper channel would have a greater cross-sectional area, making it function as a larger sediment trap; and higher salinities would increase flocculation and the deposition of suspended sediment.

Maintenance dredging is therefore projected to increase for the entire channel, from 407 to 650 mcy over the 50-year period of analysis. Expressed as average annual quantities, quantities will increase from 8.1 to 13.0 mcy per year (an increase of approximately 60 percent). Fifty-seven percent of the maintenance quantities for the Preferred Alternative would originate from the offshore channels, and 43 percent from the inshore channels. As would be expected with the offshore channel extension, maintenance dredging volumes for the offshore channel would increase more than the inshore reaches, with an increase from 162 to 370 mcy and 251 to 281 mcy, respectively. Additional capacity for the offshore reaches could be obtained by designating new ODMDSs, and the designation of four new ODMDSs is being sought (see Appendix B).

Finding areas suitable for the development of new upland PAs along the inshore reaches was difficult. The majority of land adjacent to the SNWW is either covered by residential and industrial development and existing PAs, or is coastal wetland. For this reason, considerable effort was directed toward evaluating alternatives for the placement of dredged material. Maintenance material would be used to the greatest extent possible in the resulting DMMP. A discussion of the process used to evaluate these alternatives, and a description of alternatives considered, is provided in Section 2.5.

2.4.2.2 DMMP Beneficial Use Features

All DMMP BU features proposed for inclusion in the DMMP of the Preferred Alternative are described in Table 2.4-13. Three former marsh areas on the Neches River (Rose City East, Bessie Heights East, and Old River Cove) would be combined into one large management feature called the Neches River BU Feature (see Figure 2.5-1). In the Gulf Shore BU Feature, maintenance material would be used to nourish Gulf shorelines at Texas and Louisiana Points (see Figure 2.5-2). The DMMP BU features are not being pursued as separable elements of an ecosystem restoration plan under Section 204 or 207 authorities. They are not ecosystem restoration measures, and as such, do not target a specific historical condition for the level of restoration. They are least-cost, environmentally acceptable placement features and are included as general navigation features (GNF) of the DMMP.

The Neches River BU Feature would take advantage of new work material provided by the channel-deepening project to build hydraulic containment levees within degraded, former marsh areas at Rose City East, Bessie Heights East, and Old River Cove. Each of these areas is referred to as a component of the overall Neches River BU Feature. Marsh would be created in each component using only new work, or a combination of new work and maintenance material. The Old River Cove component would be filled during initial construction with new work material alone. In the Bessie Heights East component, maintenance material would be placed incrementally in seven maintenance cycles over 28 years. At the Rose City East component, new work material would be used to construct containment levees and ridges, then the marsh would be completed with the placement of maintenance material during the first maintenance cycle following construction. For the Neches River BU Feature as a whole, 2,853 acres of emergent marsh would be restored in areas that are now open water; 871 acres of improved shallow-water habitat would be created by the formation of shallower ponds and interconnecting channels within the restored marshes; and 1,234 acres of existing fringing marsh would be nourished by winnowing fine-grained material from unconfined flows of dredged material effluent. The size of the Neches River BU Feature components and the magnitude of their ecological benefits are made possible by the large amounts of dredged material that would be generated by the proposed project, and extensive opportunities for beneficial use in the project area.

The Gulf Shore Nourishment Feature would use material from regular maintenance dredging of the eastern section of the Sabine Pass Channel to nourish eroding marsh, and possibly create new saline marsh, along a total of 6 miles of shoreline on both sides of Sabine Pass at Louisiana and Texas Points. Material would be hydraulically pumped along a 3-mile reach of shoreline, from 0.5 to 3.5 miles from each jetty. The unconfined placement of material during each 3-year dredging cycle would alternate between Texas and Louisiana, so that materials would be placed on each state’s shoreline every 6 years, for a total of 16 placement events over the 50-year period of analysis. Historic dredging records indicate that the material from Sabine Pass would average 51 percent silt, 31 percent clay, and 18 percent sand. The material would be hydraulically pumped into the nearshore zone and some material would be expected to flow over existing marsh while the remainder flows into the nearshore waters. This mix of materials does not contain typical beach-quality sand; however, resource agencies have ageed that returning the material to the littoral system would have a net beneficial effect, regardless of the material type.

Table 2.4-13
DMMP BU Features, SNWW Preferred Alternative

Beneficial Use Features	No.	Description	Size of Influence Area
Rose City East (component of Neches River BU Measure)	TX 3-1 East	Restoring 345 acres fresh marsh, 72 acres of shallow water, and nourishing 151 acres of existing marsh in two construction events. New work material from Neches River Channel will be used to restore 225-acre marsh, construct hydraulic containment levees and higher elevation features. Maintenance material from the first maintenance cycle will be used to restore an additional 120 acres of marsh.	Influence area – 568 acres
Bessie Heights East (component of Neches River BU Measure)	TX 5-2	Restores 679 acres of brackish and 1,190 acres of intermediate marsh, 660 acres of shallow-water habitat, and nourishes 651 acres of existing marsh. Marsh will be constructed with maintenance material from Neches River Channel for 28 years. New work material is used to build hydraulic containment levee.	Influence area – 3,180 acres
Old River Cove (component of Neches River BU Measure)	TX 6-1	Restores 639 acres of brackish marsh, 139 acres of shallow-water habitat, and nourishes 432 acres of existing marsh with new work material from Neches River Channel. New work material used to construct hydraulic containment levee.	Influence area – 1,210 acres
Gulf Shore BU Feature (Texas and Louisiana Points)	TX 8-11 LA 5-2/ 6-2	Nourish 3 miles of Gulf shoreline on both sides of Sabine Pass, from 0.5 to 3.5 miles from East and West Jetties, using maintenance material from Sabine Pass Channel. Unconfined placement of maintenance material along shoreline every 3 years for 50-year period of analysis (8 placement episodes). Assume 50:50 split of material between Texas and Louisiana accomplished by alternating placement in Texas and Louisiana.	Affected shoreline 6.0 miles total

2.4.2.3 Upland Placement Areas

Sixteen existing and two expanded upland PAs proposed for use with the Preferred Alternative are listed in Table 2.4-14. Existing upland PAs would be used to the greatest extent possible; however, the expansion of some existing PAs would also be required. The locations of each PA are shown on figures 2.4-1d–g, and the evaluation of PA impacts is presented in subsection 2.5.3.3.

2.4.3 Impact Analysis and Mitigation Needs Summary for the Preferred Alternative

A full summary of the impact analysis and compensatory mitigation needs for the Preferred Alternative is presented in Table 2.4-16 for each state. The calculation of impacts and benefits of the DMMP BU features and mitigation measures are described in Section 2.5 and throughout Section 4 of this FEIS.

Table 2.4-14
Upland Placement Areas, SNWW Preferred Alternative

Placement Area	Additional Cell(s)	Size (acres)	Associated Waterway Section**
5	N&S, B and C	957	Sabine Pass Channel (sections 5 and 6)
8		3,570	Port Arthur Canal (sections 7 and 8) Sabine-Neches Canal (Section 9)
9A	B	481	Port Arthur Canal (Section 8)
11		2,170	Sabine-Neches Canal (Section 10)
12		355	Neches River Channel (Section 11)
13		140	Neches River Channel (Section 11)
14		255	Neches River Channel (Section 12)
16		288	Neches River Channel (Section 12)
17		316	Not used for new work material
18	A*	432	Neches River Channel (Section 14)
21		135	Neches River Channel (Section 15)
23	A	773	Neches River Channel (sections 15 and 16)
24	A*	575	Neches River Channel (Section 16)
25	A	820	Neches River Channel (sections 17 and 18)
26		192	Neches River Channel (Section 18)
27	A, C, and D	270	Neches River Channel (Section 18)

*New cells (PAs 18A and 24A), which enlarge existing PAs.
**Waterway sections are shown on FFR Engineering Plates C-01 through C-12.

Table 2.4-15
Preferred Alternative ODMDSs

Placement Area	Size (acres)	Status	Associated Waterway Section
A	3,405	New	Extension Channel
B	3,405	New	Extension Channel
C	3,405	New	Extension Channel
D	3,405	New	Extension Channel
1	2,020	Active	Section 1
2	4,738	Active	Section 2
3	3,939	Active	Section 3
4	3,444	Active	Section 4

2.4.4 Critical Assumptions

Critical planning and environmental assumptions were made in the evaluation of the benefits and impacts of the Recommended Plan. Table 2.4-17 provides a brief summary of the major assumptions, the scientific basis or rationale behind each assumption, and an indication of the consequences if the assumptions turn out not to be valid.

Table 2.4-16
Summary of the Impact Analysis and Compensatory Mitigation Needs for the Preferred Alternative

	Texas	Louisiana	Project as Whole
Impact Analysis (AAHUs*)			
Negative Impacts (–) Before DMMP BU	–412	–1,709	–2,121
Positive Impacts Resulting from DMMP BU	1,068	210	1,278
Net Gain or Loss (–) After DMMP BU	656	–1,499	–843
Offset of Impacts to Louisiana Federal Lands from Excess Texas BU Benefits	–340	340	NA
Net Gain or Loss (–) After BU Benefits	316	–1,159	–843
Compensatory Mitigation (AAHUs)			
Total Compensation	0	1,181	1,181
Net Gain After BU Benefits & Mitigation	**316**	**22**	**338**
Impact Analysis (Acres)			
Size of Potential Impact Area	58,649	197,530	256,179
Area with No Impacts	19,421	15,247	34,668
Area of Direct Impacts	86	0	86
Area of Indirect Impacts	39,228	182,283	221,511
Net Acres of Land Loss (–) before DMMP BU	–247	–691	–938
Total Shoreline Influenced by DMMP BU	3 miles	3 miles	6 miles
Total Acres Affected by DMMP BU	4,958	0	4,958
Created Emergent Marsh	2,853	0	2,853
Improved Shallow Water	871	0	871
Nourished Existing Marsh	1,234	0	1,234
Compensatory Mitigation (Acres)			
Total Acres Affected by Mitigation	0	8,095	8,095
Created Emergent Marsh	0	2,783	2,783
Improved Shallow Water	0	957	957
Nourished Existing Marsh	0	4,355	4,355
Total Acres Affected by DMMP BU and Mitigation	**4,958**	**8,095**	**13,053**
Created Emergent Marsh	2,853	2,783	5,636
Improved Shallow Water	871	957	1,828
Nourished Existing Marsh	1,234	4,355	5,589

*AAHU = Average annual Habitat Units

Table 2.4-17
Critical Assumptions

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
FWOP Condition		
Louisiana Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) Projects in operation at Willow Bayou, Black Bayou, and Perry Ridge for remainder of project life.	Ecological effects of CWPPRA projects (reductions in land loss rates and/or salinity) based upon changes projected in environmental assessments.	If ecological benefit of CWPPRA project is less than expected, then FWOP salinity and land loss impacts would be slightly higher than expected; conversely, if ecological benefits are higher, FWOP impacts would be slightly lower than expected.
Most likely rate of RSLR estimated to be 1.1 feet in the study area by year 2069. Full potential range of RSLR estimated to be from 0.3 to 2.8 feet over period of analysis.	Eustatic sea-level rise based upon mid- to high mid-range projected by National Research Council (NRC) and Intergovernmental Panel on Climate Change (IPCC), respectively. Local subsidence component based upon long-term trends obtained from basal peat analysis. Full potential range calculated as required by Circular No. 1165-2-211.	Little consequence if RSLR is lower than expected. High rate of RSLR could result in small increase in maintenance dredging and PA levee heights for existing project; increase in hurricane tidal surge elevation; an increase in land loss due to submergence of intertidal marshes; and salinity increase. Functioning of navigation channel would not be affected; improvements at some dock facilities might be needed.
Future freshwater inflows assumed for HS modeling are slightly higher on Neches River than existing inflows; about the same as existing inflows on the Sabine River.	Future freshwater inflows were based upon demand projections and supply strategies approved by the 2007 Texas State Water Plan.	Little consequence if inflows are higher than projected. If inflows are lower than expected, FWOP ecological impacts would be higher than expected and more areas would be experiencing suboptimal salinities.
Changes in land loss rates are driven by the interaction of salinity and submergence, resulting in a reduction in plant productivity, leading to a decrease in plant growth, plant death, followed by peat collapse and wetland loss. Assumed linear relationship between change in salinity due to RSLR and change in FWOP land loss rate.	The salinity-vegetation productivity relationship is based upon algorithms developed for dominant wetland vegetation species in the study area. The algorithms were developed for the Louisiana Coastal Areas Ecosystem Restoration Study using data from a large number of professional studies.	If the relationship between salinity and land loss is different from that projected, FWOP land loss would be higher or lower than current estimates.
FWP Condition (Preferred Alternative)		
RSLR – same as FWOP because deepening project causes only negligible increase in water surface elevation.	FWP water surface elevation change determined by ERDC HS modeling.	Little consequence if RSLR is lower than expected. No FWP effect on maintenance dredging, PA levee heights, or tidal surge penetration. At high rate, all areas suitable for marsh mitigation could be susceptible to submergence. DMMP BUs protected by containment structures.
Additional land loss would result primarily from the interaction of higher FWP salinities with FWOP RSLR. Assume direct linear relationship between salinity and land loss changes.	Associating land loss with salinity increases is based upon well-documented biological responses of inundated vegetation to salinity change. No data are currently available that relate specific salinity changes to specific land loss rate changes.	If the relationship between salinity and land loss is different from that projected, FWP impacts would be higher or lower than current estimates.

Table 2.4-17, cont'd

Assumption	Rationale for the Assumption	Consequences if Assumption Becomes Invalid
Cost Estimates		
Cost estimate of the Preferred Alternative utilized appropriate probabilities of risk.	Cost risk analysis was performed using required forecasting and analysis tools. Cost contingencies developed by this analysis have been included in the total project cost estimate.	An increase in total project cost, exclusive of price level changes, of more than 20 percent of the total project cost stated in the authorizing legislation would require Congressional authorization.
It was assumed that up to 5 pipeline dredges would be available for use at one time for inshore channel dredging, and mitigation and BU marsh creation. Offshore dredging assumes use of only one hopper dredge at a time.	Assume offshore hopper dredge production averaging 7.9 mcy/yr; inshore pipeline dredge production of 7.2 mcy/year; and no more than 550 acres/year of mitigation or BU marsh creation by any one dredge.	If the assumed production rate is too high, or if the assumed number of dredges is not available, then construction would take longer and the total cost of construction would increase.
Funding		
Sufficient funding streams would be available to construct the Preferred Alternative over the assumed construction periods and to provide long-term operation and maintenance.	USACE planning policy states that plans should be developed without funding constraints. Federal funding priorities are difficult to predict.	Total project cost could be higher because of longer construction schedule. Inadequate O&M funding could cause an increase in navigation costs or adversely affect monitoring of mitigation and BU features.

2.5 EVALUATION OF ALTERNATIVES FOR THE MANAGEMENT OF DREDGED MATERIAL

2.5.1 Regional Sediment Management Objectives and Scope

The principles of RSM were applied in evaluating alternatives for the placement of dredged material from the proposed SNWW CIP. RSM is an approach for managing projects involving sand and other sediments derived from dredging and other activities in riverine, estuarine, and coastal systems (USACE, 2006b). Its major objective is the retention of sand or other sediments in natural aquatic systems, thereby supporting a more sustainable process and potentially reducing project costs (Martin, 2002). RSM incorporates many of the principles of watershed planning, but applies them in the context of dredging and other activities that influence sediment resources. It broadens the problem-solving perspective from a project-specific scale to a larger spatial and longer-term perspective. This requires the integration of a broad range of disciplines and collaborative partnerships among stakeholders. The USACE authorities and policies that support implementation of RSM are discussed in Technical Note No. 8 for the RSM Demonstration Program (USACE, 2003a).

The geographic focus of an RSM analysis is a sediment system, on a scale that is relevant to issues (e.g., dredged material management or processes like erosion or shoaling) that have been identified by stakeholders in the region. The RSM study area essentially coincides with the SNWW study area and contains riverine, estuarine, and coastal environments. It is large enough to facilitate understanding of sediment processes and behavior and the inherent interconnectedness of all parts of a sediment system. The RSM study area includes the existing 65-mile-long SNWW navigation channel that extends from

22 miles offshore in the Gulf, through a jettied entrance at Sabine Pass, up artificial canals on the west side of Sabine Lake, and finally up the Neches River Channel to the City of Beaumont. The SNWW area of analysis incorporates all of the existing and proposed navigation and placement features, and significant inflows and structures that affect the system. The littoral portion of the study area extends from Holly Beach, Louisiana, to Sea Rim State Park in Texas, roughly a distance of 40 miles. It extends into the Gulf along the existing Entrance Channel, proposed channel extension, and ODMDSs for a distance of roughly 40 miles; and it extends inland from the coastline approximately 40 miles to incorporate the tidally influenced reaches of the Sabine and Neches rivers watersheds and Sabine Lake.

The Texas Coastwide Erosion Response Plan has identified several parts of the study area as "critical erosion areas" because of impacts to habitats and traffic safety from ongoing erosion, and has called for an increase in the beneficial use of dredged material from the SNWW project to help address these issues. The plan was developed as part of the Texas Coastal Erosion Planning and Response Program (CEPRA) (GLO, 2004, 2005). The program has identified the Gulf shoreline between Texas Point and Sea Rim State Park as a critical erosion area. It attributes the erosion, in part, to a lack of sediment coming down the Sabine and Neches rivers, and the interruption of longshore sediment transport by the SNWW jetties. The CEPRA Plan recommends that long-term regional sediment management be utilized, along with highway realignment and beach dune restoration, to protect the important coastal evacuation route of SH 87 in Jefferson County. As described below, the Gulf Shore BU Feature will provide a long-term, RSM approach to restoring some sediment to the littoral zone in this area of high erosion. In Orange County, the CEPRA Plan calls for restoration of 9,400 acres of marsh in the Lower Neches River using dredged material to raise soil elevations in the former marsh areas that have become open water. These are the same marsh areas (i.e., Rose City, Bessie Heights, and Old River Cove) that have been combined into the Neches River BU Feature. The evaluation of these beneficial use features is described more fully later in this chapter.

2.5.2 Description of the SNWW Sediment System

2.5.2.1 Geomorphology

The modern coast of the northwest Gulf is the product of dramatic processes that occurred at the end of the Holocene sea level rise. The lowstand occurred approximately 20,000 to 18,000 years before present (B.P.) when the sea level was about 350 feet lower than today. Rapid sea level rise occurred until 7,000 to 6,000 years B.P., and then slowed to reach the modern stillstand about 3,000 years B.P. (Blum et al., 2002; Frazier, 1974; Nelson and Bray, 1970). The offshore shoal area of Sabine Bank is a relict shoreline that formed during this period. As the sea level rose, the Sabine and Neches rivers backfilled incised valleys that had developed during the lowstand. The Chenier Plain on both sides of Sabine Pass was created with sediment transported by the westernmost of the Mississippi River's major distributaries (Byrnes and McBride, 1995). The Mississippi River never flowed directly through this region, and thus much less erosion of the Pleistocene surface occurred (Penland and Ramsey, 1990). Rather than the hundreds of feet of silty sediment that overlays the Pleistocene surface in the Louisiana coastal plain to the east, the Pleistocene surface lies beneath about 49 feet of sediment in the Chenier Plain region. It is composed of a series of parallel beach ridges that evolved as a series of prograding mudflats intermittently reworked into sandy or shelly ridges. Sabine Lake formed in the elongated drowned river valley of the Sabine River. The Sabine River and the Neches River empty into the northeast and northwest corners, respectively, of Sabine Lake.

The modern Gulf shoreline from Holly Beach to Sea Rim State Park is composed of mudflats, mud washover flats, clay marsh platforms, sandy washover flats, and some sandy beaches (Louisiana Department of Natural Resources [LDNR], 1997; PBS&J, 2006; USACE, 1971a). The low marshy areas on the east and west sides of Sabine Pass are known as Louisiana and Texas Points, respectively. Both shorelines within 10 miles of Sabine Pass are entirely undeveloped, and public access is limited. In Texas, a section of SH 87 has been abandoned since 1989 due to shoreline erosion. Most of the shoreline in the Texas portion of the study area is located within the Texas Point NWR. In Louisiana, SH 82 crosses Sabine Lake where the lake begins its constriction into Sabine Pass, and does not approach the coastline until it nears the small community of Johnson's Bayou. The property south of SH 82 is privately held, with the exception of the SNWW PA 5 on Sabine Pass. Recreation and wildlife preservation have been the major uses of the area; however, recently the new Sabine Pass LNG facility has been constructed on the waterway northwest of PA 5.

The only major inlet in the sediment system is Sabine Pass, the jettied entrance for the SNWW. These navigation structures extend seaward, blocking longshore sediment transport and carrying sediment out of the littoral zone. The Sabine Pass Jetties were built between 1883 and 1885 with east and west completion lengths of 25,000 feet (4.7 miles) and 22,000 feet (4.2 miles), respectively (Alperin, 1977). Longshore transport of sediments from the east is also affected by navigation jetties at Calcasieu Pass (USACE, 2004a). Construction on the east jetty at Calcasieu Pass began in 1893 and the west jetty in 1986 (USACE, 1961). Over the next 45 years, east and west Calcasieu jetties reached 10,500 feet (2 miles) and 8,200 feet (1.6 miles), respectively.

Offshore of Sabine Pass, the bottom slope averages 6 feet per mile until roughly 1 mile offshore, after which it steadily decreases to an average 1 foot per mile through roughly 10 miles offshore (White et al., 1987). Thus, for most of its extent the shelf is gently sloping and (with the exception of Sabine Bank) is relatively featureless. The Sabine Bank is the principal topographic feature with approximately 25 feet of relief. Sandy muds and clay muds predominate the surface inner shelf region; however, the surface of virtually the entire area is covered by a sheet of sand approximately 2 feet thick (Anderson and Wellner, 2002; PBS&J, 2004b). An extensive outcrop of Beaumont clay is located nearshore and within 2 feet of the sediment surface, beginning near Sea Rim State Park and extending westward (Nelson and Bray, 1970). The Beaumont clay is derived from coastal and deltaic plain silts and clays that were deposited on the continental shelf during the previous lowstand. The clay outcrops from a complex, eroding scarp face with relief of approximately 2 feet (Pacific International Engineering [PIE], 2003).

Sabine Bank is the only area that contains significant quantities of beach-quality sand (Morton et al., 1995). It is an elongated feature, located approximately 17 miles south of the mouth of Sabine Pass and oriented roughly parallel to the coast (Blum et al., 2002). The main body of the bank (Sabine West Bank) is 20.5 miles long, and water depths over the bank range average 39 feet below mean low water. The existing SNWW Entrance Channel passes approximately 0.75 mile to the east of its eastern edge. A smaller body of Sabine Bank (Sabine Bank East), approximately 10.5 miles long, is located east-northeast of the SNWW channel. Existing ODMDSs 1 and 2 are located north and south of the eastern end of the Sabine West Bank, sufficiently distant that materials placed there do not flow onto them. All of the four existing and four proposed ODMDSs are evenly spaced on the west side of the existing and proposed extension channel. They were located on the west side of the channel so they will be downstream of the most prevalent circulation currents in the northwest Gulf.

2.5.2.2 Wind, Tides, and Circulation

The hydrodynamic regime in the northwestern Gulf results from a complex interaction of tides, meteorological driving forces, freshwater inflows, and Coriolis acceleration. Both local conditions and the overall Gulf circulation pattern affect the area. In addition, major storms profoundly influence waves, tides, currents, and sediment movement.

The combination of a broad continental shelf and low waves in the Gulf allows local winds to play a more dominant role in shoreline dynamics in this area than on most other beaches around the U.S. (King, 2007). Local winds can directly modify longshore currents within the surf zone and in the nearshore environment. The average wind direction from a buoy off Sea Rim State Park is from the south-southeast (PIE, 2003). However, wind direction is more southerly in summer months and more southeasterly at other times of the year. Average speeds are fairly constant at 9 to 13 miles per hour throughout the year, reaching maximum in April and May.

Astronomical tides are generally small in the Gulf. They vary from diurnal to semidiurnal as a function of the moon’s declination, with an average amplitude of approximately 1 foot (King, 2007). During average conditions, waves in the nearshore are depth-limited and controlled by water levels, the mild nearshore slope, and the possible presence of a soft mud bottom (PIE, 2003). The coast of the Chenier Plain between Sabine Pass and Calcasieu Pass is also microtidal, with tides ranging from 2.0 to 2.4 feet. Waves come from the south about 16 percent of the time and from the south-southeast 28 percent of the time (Byrnes and McBride, 1995).

A major feature that dominates circulation in the eastern Gulf is the Loop Current, a continuation of the Yucatan Current which enters the Gulf through the Yucatan straits. There are two important semipermanent currents that diverge from the Loop Current; the one in the northwestern Gulf circulates counterclockwise (Rouse et al., 2004). Inner-shelf currents in the Gulf off the Louisiana and upper Texas coast flow westward and move downcoast during the late fall, winter, and early spring. This flow is highly responsive to wind forcing and may briefly reverse direction and flow upcoast. This reversal typically occurs during late spring, so that for a month or more the mean current in this area may be eastward. During the summer, when winds are weaker, the coastal waters are highly stratified, and surface flows may not flow in the same direction as near-bottom currents.

Bottom currents have a strong effect on sediment movement on the shelf. A study of water velocities needed to cause rapid erosion on sediments similar to those in the study area found a critical erosion velocity of 0.47 knot, with little variation among sand, silt, or clay (Moherek, 1978). The bottom ocean currents near Sabine Pass should have sustained bottom velocities of at least twice the critical erosion velocity for several days each year. Within approximately 40 miles of the Gulf Coast in this area, bottom current will reach a maximum velocity of about 3.9 knots every 3 years and sustain velocities of 1 knot or greater for several days once a year (EPA, 1982). Pre- and postdredging surveys of the existing ODMDSs off Sabine Pass provide corroborating evidence of this sediment movement. Maintenance material from recurrent dredging placement episodes disperses after each placement and does not accumulate.

2.5.2.3 Coastal Shoreline Erosion Impacts

The changes in sediment transport, while very small, can be expected to have some effect on the rates of shoreline erosion. Under the Preferred Alternative, there is a slight reduction in the erosion rate near the jetties. Near the jetties, the average rate of shoreline accretion was calculated to be as much as 60 feet/year. However, between 0.5 mile and 3 to 4 miles on either side of the jetties, the erosion would be increased by less than 0.5 foot/year for a 50-foot project and farther from the jetties than that, the shoreline change would decrease to zero. The effect of the 48-foot channel on the Gulf shoreline between 0.5 mile and 3.5 miles from each jetty was estimated to be 0.42 foot/year based upon the 45- and 50-foot project effects.

The Gulf Shore BU Feature should have a positive effect on reducing shoreline erosion. The presence of additional fine-grained sediments in the littoral system, which would be provided by the BU feature, should reduce the current erosion rate and minimize the small increase in shore erosion predicted with the project. In systems that have an abundant supply of fine-grained sediments, the presence of additional muddy sediment in the nearshore environment may attenuate waves and lessen wave-induced erosion (Hsiao and Shemdin, 1980; Tubman and Suhayda, 1976; Wells and Kemp, 1986). Furthermore, the predominantly fine-grained sediment provided by this BU feature should contribute to mudflat accretion by periodically moving onshore and becoming shore-attached. On the western Louisiana and eastern Texas coasts, sediments accumulate as mudflats and underwater mudshoals (or “fluid mud”) in the nearshore region. Nearshore, fluid mud can be trapped against the shoreline by prevailing south and southwesterly winds, and storms carry the trapped muddy ooze onto the chenier shoreline (Morgan et al., 1958; Wells and Kemp, 1982, 1986). Accretion of the shoreline can then occur by poorly understood processes (Huh et al., 1991; King, 2007; PIE, 2003).

Although the BU sediments would be largely fine grained, approximately 18 percent of maintenance material is expected to be sand. Sands that are deposited onshore would nourish and stabilize eroding marshes and sand deposited in the nearshore zone should stay in the nearshore environment, moving back and forth across the shoreface (Wamsley, 2008). Sand placed at Louisiana Point should remain on the shoreface where it was deposited; no significant amounts of sand are expected to enter the Jetty Channel. On erosive mud shorelines like those in the BU area, the sand percentage should increase, and it would form sandy lenses or a veneer over the mud shoreline substrate. As the sand lenses thicken, the sands help protect the underlying mud from further erosion (Nairn, 1992). However, in smaller quantities, sand can also accelerate erosion of a mud beach. If the consolidated mud is not covered by a sand veneer, any sand that is mobilized by wave action would act as a scouring agent (King, 2007).

2.5.2.4 Inland Shoreline Erosion Impacts

The primary area of concern for inland shoreline impacts is Pleasure Island along the confined channels of the Port Arthur and Sabine-Neches canals (Parchure et al., 2005). No increase in the existing erosion rate is predicted with the project for the eastern shore of Sabine Lake. The primary mechanism for shoreline erosion associated with the project is from passage of large vessels. Maynord (2005) investigated the mechanisms of ship-induced bank recession (shoreline erosion). The analysis employed a numerical model (HIVEL2D) to simulate the ship-induced velocity at the bank and employed information on the vessels in the existing and future fleets and information on the speeds that would be needed in both the No-Action and Preferred alternatives. The analysis focused on two sites on Pleasure Island; the north site is in the Sabine-Neches Canal, and the south site is in the Port Arthur Canal. The north site has no existing erosion protection, while the south site has riprap protection. Neither site will have a change in channel width. The analysis was calibrated to the existing rates of bank recession, and it used the model to account for differing numbers of vessel trips projected for the years 2030 and 2060 for both the No-Action and 50-foot alternatives. The Preferred Alternative is expected to have a lesser effect than the 50-foot alternative.

Maynord (2005) found that the rates of erosion are lower for the 50-foot alternative than for the No-Action Alternative at both the north and south sites for both 2030 and 2060 traffic levels. Overall, the effect of the Preferred Alternative should be to reduce the rate of erosion on inland channels relative to the No-Action Alternative because of fewer vessel trips that are predicted with the Preferred Alternative than in the No-Action Alternative.

2.5.2.5 Longshore Transport

In general, the longshore movement of littoral sediments in the study area is from the east to the west (King, 2007; Morang, 2006; USACE, 2004a). In the recent past, the estimated net longshore sediment transport to the west ranged from 47,000 to 97,000 cy/year east of Sabine Pass (USACE, 1971a). West of Sabine Pass, the typical yearly net longshore sediment transport is to the southwest (Carothers and Innis, 1960; Mathewson, 1987; USACE, 1971b), with an occasional reversal of direction at Sea Rim State Beach (King, 2007; Mason, 1981). At Sea Rim State Park, the typical net transport to the southwest was about 70,600 cy/year; for the atypical reversal to the northeast, the net transport rate was 35,000 cy/year (Mason, 1981). Another study of coastal geomorphology and shoreline erosion in Jefferson County was conducted by PIE (2003) in conjunction with ongoing studies of erosion impacts to SH 87. PIE calculated longshore sediment transport using both Galveston Buoy and Wave Information Study data. In general, the gross sediment transport rate was found to be higher toward Galveston Island. Transport divergence was indicated near Sea Rim State Park, in the vicinity of two areas of high erosion along Texas Point.

Longshore transport and wave modeling have been performed, and a sediment budget has been prepared for the study area in conjunction with a shoreline erosion study of the Texas coast from Sabine Pass through Galveston Island (King, 2007; Morang, 2006). These studies have confirmed that the littoral system in the study area is dominated by fine-grained sediments. The shorelines along Texas and Louisiana Points are primarily composed of consolidated mud (King, 2007; USACE, 2004a). Farther to the west, the consolidated mud substrate is overlain by sand veneers and is only occasionally exposed. Aside from the prevalence of fine-grained sediments along Texas Point, there was no real trend in median grain sizes in the study area. In Louisiana, the shoreline is similar to those found in Texas for about 2 miles east of the jetty and then it transitions to a sandy beach that reaches toward Ocean View Beach. Sediment transport and deposition are distinctly different on mud shorelines than on sandy beaches (King, 2007). Once eroded, cohesive sediments (clays and silts) are generally carried in suspension until deposited in a less-energetic environment (e.g., deeper water outside the surf zone or in wave-sheltered areas such as quiet bays and estuaries), and so are lost to the littoral system.

On sand beaches, the mobilized sand generally stays within the active profile. This is the primary reason that most of the world's beaches are composed of sediments having diameters greater than 0.10 mm. The depth of closure, or the sedimentologically active zone, has recently been determined to be approximately 19.7 feet deep off the upper Texas coast (King, 2007). Sand deposited any deeper than this point is unable to move any closer to shore. On the Texas side of Sabine Pass, this is roughly 3 to 4 miles from shore; off Louisiana Point, this point is roughly 2 to 3 miles from shore.

In regions like the study area that have large supplies of fine-grained sediments, the nearshore seabed can be blanketed with thick, unconsolidated, gel-like, mud oozes called "fluid mud." There are numerous anecdotal reports of the presence of floating rafts of "fluid mud" on the Gulf's surface west of the Atchafalaya River mouth in Louisiana, and off Texas Point and Sea Rim State Park (Block, 1984; PIE, 2003). Nearshore, the fluid mud can be trapped against the shoreline by prevailing south and southwesterly winds, and storms carry the trapped muddy ooze onto the chenier shoreline (Morgan et al., 1958; Wells and Kemp, 1982, 1986). Accretion of the shoreline can then occur by poorly understood processes (Huh et al., 1991; King, 2007).

2.5.2.6 Shoreline Descriptions

Jefferson County and Cameron Parish coastlines in the study area are mainland beaches fronting a chenier plain that formed from a Pleistocene promontory overlain by Holocene marginal deltaic sediments (King, 2007; USACE, 2004a). The upland area adjacent to the coast is a relatively flat, gently sloping terrain with marsh elevations of 1 to 2 feet mean sea level and ridge elevations of 5 to 6 feet mean sea level. Saline marsh vegetation covers the upland area behind the eroding shoreface. In the Texas Point NWR, a fillet of muddy substrate that was created by rapid deposition over approximately the last 100 years lies seaward of the chenier ridges. For the period between 1883 and 1970, the net accretion was documented at 2,225 feet (Morton, 1975). The fillet of recent deposits recedes rapidly and disappears approximately 0.5 mile from the West Jetty, where the Chenier Plain again fronts the Gulf until it ends about 18 miles from Sabine Pass (PIE, 2003).

The shoreline in the Texas Point NWR (between Sabine Pass and Sea Rim State Park) is a muddy shoreface composed of consolidated mud (King, 2007; PIE, 2003). A thin veneer of sand thrown up onto the marsh edge by storms covers some areas of the mud substrate. Farther west, the Sea Rim State Park area is a sediment transport convergence zone, and the beach typically has a substantial veneer of sand. In Louisiana, the coastline for approximately 10 miles east of the jetty contains tidal sand/mudflats, sand bars and sandy beaches with tidal flats (PBS&J, 2006). A narrow tidal sand/mud flat, ranging from 30 to 450 feet in width, extends for about 1.5 miles east of the jetty, and then transitions to a sandy beach. These beaches vary in width from 50 to 300 feet and end at an eroded, low mud bank shoreline. A sand bar is present in the nearshore zone that is the result of the beneficial placement of dredged material by Cheniere Energy in conjunction with construction of the Sabine Pass LNG facility. The 10-to-150-foot-wide bar begins about 0.5 mile from the jetty and extends for about 1 mile to the east. It lies roughly parallel to the shore, between 4,000 and 1,200 feet offshore.

2.5.2.7 Historical Shoreline Change in the Study Area

The northwest Gulf Coast system is sand starved, and essentially no modern-day sand is being delivered to these beaches (Lee, 2003; Morang, 2006; Morton, 1977). The only coarse-grained sand reaching the Texas shores appears to originate from the erosion of underlying Pleistocene barrier-strand plain deposits, which contain lenses of fine-grained and poorly sorted sands in massive clay and silt deposits (Isphording et al., 1989). The lack of delivery of coarse-grained sand during the modern stillstand has contributed significantly to shoreline erosion in the area. The very limited coarse-grained load of the Sabine and Neches rivers is deposited in bay-head deltas in Sabine Lake rather than on the coast (Mason, 1981; Morang, 2006; USACE, 1971b). Therefore, the limited sand in the northwest Gulf coastal system either migrated up the shoreface with the Holocene sea rise or was eroded from relict Pleistocene deposits.

Chronic erosion is believed to be associated with the diversion of sand and other sediment resulting from channelization and regulation of the Mississippi and Atchafalaya rivers to the east, and the Sabine and Neches rivers in Texas. The Calcasieu and Mermentau rivers also do not supply coarse-grained sediments, and the Cameron jetties deflect the little material that does exist away from the Holly Beach area, so that it accumulates to the west at Long Beach, Louisiana's westernmost sandy beach (LDNR, 1997; USACE, 2004a). The Sabine Pass jetties also intercept sediment moving westward in the littoral drift, creating a wide, muddy, tidal flat next to the east jetty (PBS&J, 2006; USACE, 2004a). On the Texas side, a 0.5-mile-wide fillet of silt and mud, located immediately adjacent to the west jetty, intercepts sediments moving from the west during periodic reversals near Sea Rim State Park in the dominant longshore movement (PIE, 2003).

Shoreline change has been extensive in this region and continues to be an ongoing problem. In the area between Ocean View Beach and the Sabine jetties, the shoreline prograded seaward at an average rate of +12.9 feet/year between 1883 and 1994. Recently, however, accretion has slowed to +1.2 feet/year, and the behavior of this shoreline has become erratic, with change rates varying between –13.2 and +14.7 feet/year (USACE, 2004a). East of Ocean View Beach, the 10-mile-long coastline to Holly Beach fronts a series of chenier and beach ridges that provided a foundation for roadways and commercial development before it was essentially destroyed by Hurricane Rita in 2001. Persistent erosion in this area, on the order of –4.3 feet/year between 1985 and 1998, was recorded here prior to the hurricane (USACE, 2004a). Hurricane Rita's storm surge at Louisiana Point was 10.6 feet as recorded by U.S. Geological Survey (USGS) sensors (Farris et al., 2007). The surge deposited 3.3 feet of new sediment on the Hackberry Beach chenier ridge and inundated thousands of acres of coastal marsh. Bar welding to the lower shoreface was also evident (Guidroz et al., 2006). Immediately after the storm, hundreds of acres of marshay cordgrass marsh in Cameron Parish appeared to have been severely impacted by extensive flooding of high-salinity waters. When the water finally subsided, the vegetation in many areas appeared dead, and the marsh had areas that were 30 to 50 percent devegetated. Over time, porewater salinity levels should decline as rainwater flushes salinity from the system (Farris et al., 2007). On the Texas side of Sabine Pass, a 0.5-mile stretch of shoreline adjacent to the west jetty is aggrading at a rapid rate, but beyond this narrow zone to the west, is an active erosion zone extending approximately 15 miles to the vicinity of Sea Rim State Park (Morang, 2006). This eroding stretch of the Jefferson County coastline is experiencing the largest erosion rate on the upper Texas coast, up to 40 to 50 feet/year (King, 2007). It has been identified as a "critical erosion area" by the Texas Coastwide Erosion Response Plan because of threats to traffic safety and wildlife habitat. Shoreline erosion has destroyed a portion of SH 87, an important hurricane evacuation route, and is eroding coastal wetland habitat at Texas Point and McFaddin NWRs (GLO, 2004, 2005).

2.5.2.8 Sabine Pass Sediment Budget

New littoral transport rates have recently been calculated for the Sabine Pass littoral zone. The Sabine Pass sediment budget (Morang, 2006) applied shoreline change statistics that were computed from changes in sediment volume for littoral cells, using cross-shore profiles that were projected with an ERDC modeling study (King, 2007). The sediment budget focused on characterizing sediment movement in the coastal segments of the navigation channel and nearby Texas shoreline. Accurate estimates of the percentage of total transport that is suspended sediment load from the inshore area were not available. Six of the 23 cells defined for this study are relevant to this discussion—three cells (the Sabine Pass Channel, the Sabine Jetty Channel, the Sabine Outer Bar Channel) were used to analyze sediment movement in the navigation channels through Sabine Pass and past the jetties; three other cells (the Sabine Fillet, Texas Point NWR, and Sea Rim State Beach) were used to calculate sediment movement along the littoral zone westward of Sabine Pass. A summary of the sediment budget results is presented in Table 2.5-1.

2.5.2.9 Existing Project Shoaling and Sediment Transport Conditions

The following summary of shoaling and sediment transport conditions for the existing SNWW includes all segments of the existing SNWW navigation system. The analysis of channel sections covered by the sediment budget (see Table 2.5-1) is derived primarily from Morang (2006); dredging cycle lengths, velocity data, average percentages of sediment sizes, and dredging quantities for channel reaches not covered by the sediment budget were obtained from the SNWW Sediment Study (Parchure et al., 2005); other supporting analyses are identified as the data are presented. The discussion begins with the upstream end of the SNWW (the Neches River Channel) and moves downstream through the confined Sabine-

Neches and Port Arthur canals, the Sabine Pass Channel, and then offshore into the Sabine Pass Jetty Channel, the Sabine Pass Outer Bar Channel, and the Sabine Bank Channel. Finally, the interaction of the channel and adjacent shoreline sections is described.

Table 2.5-1
Sediment Budget for Sabine Pass (adapted from Morang, 2006)*

Cell	Sources and Quantity (1,000 cy per year)	Sinks and Quantity (1,000 cy per year)	PA/ODMDS and Quantity (1,000 cy per year)
Sabine Pass Channel	866.7 (approximately 20% sand) from Port Arthur Canal and Sabine Lake	274.2 mud and sand into Jetty Channel	592.5 into PA 5
Sabine Pass Jetty Channel	274.2 (mud and minor sand) from Sabine Pass Channel	Unknown quantity of fine-grained material carried in suspension offshore	289.1 to ODMDS 4 (dispersed by shelf circulation, storm and tidal currents)
	14.9 (mud) offshore		
Sabine Outer Bar Channel	Unknown amount from Sabine Jetty Channel (possible mud input)		1722.6 to ODMDS 3 (dispersed by shelf circulation, storm and tidal currents)
	1,722.6 from undetermined source (littoral sediments and/or ODMDS)		
Sabine Fillet	25.1 longshore transport from Texas Point NWR (west)	14.9 longshore transport (mud & minor sand) to Jetty Channel	
		10.2 shoreline growth at Sabine mud fillet	
Texas Point NWR	434.2 from beach erosion (+90% mud)	152.0 overwash losses	
		173.7 mud lost offshore	
		25.1 longshore transport of mud to east	
		83.5 longshore transport to west (sand & shell)	
Sea Rim State Beach	83.5 longshore transport from Texas Point NWR (east)	117.7 beach growth at Sea Rim State Beach	
	34.3 longshore transport from McFadden NWR (west)		

*Sediment Budget quantities are based on 25 years of data from Galveston District's Dredging Database. SNWW CIP without-project shoaling quantities are based on data from 1967 to 2001. A cross check and conversion verified that the quantities are similar.

2.5.2.9.1 Neches River Channel

Dredging cycles on the Neches River Channel vary from 3 to 4 years along the eastern half of the channel near Sabine Lake to 6 years along the western segment near Beaumont. Approximately 3.1 mcy/cycle are dredged from eastern channel sections 11, 12, 13, 14, and 15 and placed into PAs 12, 13, 14, 16, 18, 21, 23, and 23A. Approximately 3.3 mcy/cycle are dredged from western channel sections 16, 17, and 18 and placed in PAs 24, 25, 25A, 26, 27A, 27C, and 27D near Beaumont. Peak ebb and flood velocities are low (0.8 foot/second and 0.3 foot/second, respectively). Bed sediments average 62 percent silt and clay and 38 percent sand.

2.5.2.9.2 Sabine-Neches and Port Arthur Canals

These canals traverse the confined channel segment between the City of Port Arthur and Pleasure Island. Sabine-Neches Canal sections 9 and 10 are dredged every 4 years. Approximately 3.7 mcy/cycle are placed in PAs 8 and 11. Bed sediments average 78 percent silt and clay and 22 percent sand. Port Arthur Canal Section 7 is dredged every 3 years and approximately 1.8 mcy/cycle are placed in PA 8. Section 8 and the Taylor Bayou Channels and Basins are dredged every 2 years; approximately 2.3 mcy/cycle are placed in PAs 8, 9, and 9A. Peak ebb and flood velocities are 2.6 and 2.2 feet/second, respectively. Bed sediments average 84 percent silt and clay and 16 percent sand. The junction of the Port Arthur Canal, Taylor Bayou Channel, and the Sabine Pass Channel is an existing dredging hot spot, often requiring dredging more frequently than the 2-year cycle. This is due, at least in part, to a rapid decrease in velocity as the flows move into the much wider junction. In addition, existing erosion along the channel side of Pleasure Island may be returning sediment to the system (Parchure et al., 2005).

2.5.2.9.3 The Sabine Pass Channel

Channel sections 5 and 6 are dredged every 3 years and approximately 1.9 mcy/cycle are placed in PA 5. Bed sediments average 70 percent silt and clay and 30 percent sand. There are no obvious sand sources because the banks of the channel are low mudflats. Little sand reaches the open coast from the Sabine and Neches rivers because Sabine Lake is an efficient sediment trap and most of its coarse material is deposited in the lake or trapped in the lower alluvial reaches of the rivers. Since the dredged material is removed from the system, some mechanism must be replenishing the sand. It may be delivered to this channel by unusually high runoff from Sabine Lake or the Port Arthur Canal. Although ebb and flood velocities are roughly equal through this section, lower velocities are present where Sabine Lake discharges into the channel; shoaling rates are higher than average around this discharge point. Peak ebb and flood velocities in the remainder of the channel are 4.0 and 3.2 feet/second, respectively. Negligible amounts of material come from the littoral system, entering the channel and moving upstream. Conversely, plumes of fine-grained material can be seen moving through the pass into the Gulf in satellite images. This material disperses over the continental shelf and does not contribute to the littoral budget.

2.5.2.9.4 The Sabine Pass Jetty Channel

Section 4 is self-scouring and needs far less frequent maintenance dredging than the other coastal reaches. Ebb velocities are high, peaking at about 3.5 feet/second, and flood velocity reaches 3.0 feet/second. Despite this jetting action, on the average about 1.1 mcy/cycle of dredged material are placed in ODMDS 4 in a 5-year dredging cycle. Sediment delivered by the Sabine Pass Channel is predominantly silt and some sand, and about 5 percent of the total transport comes from the littoral system. A small boat cut in the east jetty may allow material carried by the longshore current moving west from Louisiana to enter the channel (PBS&J, 2004b). Bed samples average 89 percent clay and silt and 11 percent sand. Before- and after-dredging bathymetry surveys have demonstrated that the material placed offshore in the ODMDS does not accumulate; it disperses quickly after placement in the offshore environment.

2.5.2.9.5 The Sabine Pass Outer Bar Channel

Section 3 is the first 3.4 miles of navigation channel outside of the jetties. Ebb velocities fall rapidly as the channel discharges over the Outer Bar. Peak ebb velocities fall from about 3.5 feet/second within the jetties to 2.7 feet/second just beyond the jetties, to 1.3 feet/second near the intersection with the Sabine Bank Channel. Peak flood velocities of 3.0 feet/second within the jetties fall to 2.4 feet/second just beyond the jetties, and to 0.4 foot/second at the end of the channel reach. It appears that little material moves from the Sabine Pass Jetty Channel into the Sabine Outer Bar channel, based upon the balance of material entering versus what is removed by dredging. Yet, the shoaling rate in this section is very high. Approximately 1.9 mcy/cycle are removed yearly and placed in ODMDS 4. Bed samples average 96 percent silt and clay and 4 percent sand. The source of the sediment is undetermined. Existing and proposed ODMDSs are located west of the channel because the mean current flow in this area is westward most of the year. However, this flow reverses and moves eastward for a month or longer during the late spring (Rouse et al., 2004). During periods of reversal, sediment may drift back into the channel from ODMDS 4. However, typical flow patterns move ebb flows to the south/south-southwest just beyond the jetties, and flood flows generally come from the east (Parchure et al., 2005). Furthermore, anecdotal accounts from the Sabine Pilots Association report a strong east to west current crossing just outside the jetties in the vicinity of ODMDS 4 (Webb, 2003).

2.5.2.9.6 The Sabine Bank Channel

Sections 1 and 2 (totaling 6.6 miles long) extend the navigation channel into the open Gulf. They are dredged every 4 years, and approximately 4.2 mcy/cycle are placed in ODMDSs 1 and 2. Bed sediments average 76 percent silt and clay and 24 percent sand. Ebb and flood velocities are nearly equal (ranging between 0.25 and 0.70 foot/second), but the velocity pattern is erratic. Rapid shoaling is not a problem in this reach, and no other management concerns are known.

2.5.2.9.7 Adjacent Gulf Shorelines

At Louisiana Point, the littoral current has supplied sufficient sediment in the recent past to cause shoreline progradation between Ocean View Beach and the Sabine jetties (USACE, 2004a), and create a wide tidal mudflat against the jetty (PBS&J, 2006). Some fine-grained sediment from this westward littoral current may be entering the Sabine Pass Jetty Channel through a small boat cut in the east jetty (PBS&J, 2004b).

All but the easternmost wedge of Texas Point (the Sabine Fillet) is undergoing severe beach erosion, with shoreline retreat of up to 1,150 feet between 1974 and 2000. Shoreface sediment losses are approximately 434,200 cy/year (see Table 2.5-1). Longshore transport to the west carries 20 percent to Sea Rim State Beach (PIE, 2003), 35 percent is lost to overwash, and 40 percent is carried offshore. Approximately 6 percent moves eastward, carried by periodic reversals in the dominant longshore current (King, 2007; PIE, 2003). The west jetty intercepts about 40 percent of the total eastward transport, creating a ½-mile-wide fillet of silt and mud against the jetty; the remainder is carried into the Sabine Pass Jetty Channel.

In contrast to Texas Point, Sea Rim State Beach is located in a convergence zone and receives 117,700 cy/year (see Table 2.5-1) of littoral material from both the east and west. About 70 percent is carried by longshore transport from the east at Texas Point, and 30 percent comes from McFaddin NWR to the west. The accreting beach is composed of sand (0.10 to 0.14 mm in size) and shell fragments, underlain by mud.

2.5.3 Analysis of Sediment-related Problems and Opportunities

This section describes RSM problems and opportunities that were identified by the SNWW study and presents the results of a preliminary screening that was designed to identify potential beneficial uses for the dredged material that would be generated with the Preferred Alternative.

The principles of RSM were applied to ensure that the dredged material arising from the SNWW CIP would be viewed as a valuable resource, integral to economic viability and environmental sustainability of the region. In developing the DMMP for the project, this study searched for opportunities to achieve savings by defining sediment-related problems, coordinating projects, and identifying opportunities for beneficial use (Martin, 2002). The large quantities of dredged material that would be generated by the Preferred Alternative created an ideal opportunity for the exploration of the beneficial use of dredged material. A series of public workshops and extensive ICT consultation evaluated a wide array of opportunities to use dredged material beneficially (GEC, 2002; Turner Collie & Braden, 2003).

A variety of private stakeholders, State and Federal resource agencies, and USACE engineering and scientific experts identified the following existing and FWOP sediment-related problems in the region:

- Lack of sand in the littoral system
- Interruption to the littoral system caused by SNWW jetties
- Extensive shoreline erosion at Texas Point
- Erratic accretion and erosion at Louisiana Point
- Rapid shoaling in the Sabine Pass Outer Bar Channel
- Rapid shoaling in the Port Arthur Junction

- Erosion of west side of Pleasure Island
- Erosion of Sabine Lake eastern shore
- Lack of sediment recharge to, and continuing loss of, sediment from emergent marshes

The following FWP impacts that could potentially be addressed with the beneficial use of dredged material or other project elements were also identified:

- Project impacts associated with the creation of new ODMDSs for the Extension Channel
- Project impacts associated with the creation of new upland PAs to accommodate new work material and increased quantities of maintenance material over the period of analysis
- Project impacts associated with a small increase in Gulf Coast shore erosion within 3.5 miles of each jetty
- Project impacts to cypress-tupelo swamps and intertidal marshes from reductions in biological productivity due to project-induced salinity increases and marsh loss
- Additional advance maintenance due to a higher than average increase in shoaling in the Sabine Pass Outer Bar Channel, one section of the Sabine Pass Channel, the Port Arthur Junction, and portions of the Neches River Channel

2.5.3.1 Preliminary Screening – Features Eliminated From Consideration

Opportunities to use dredged material beneficially to address these sediment-related concerns were suggested by public workshop participants and the ICT and/or developed by the USACE technical studies. These suggestions resulted in the evaluation of a wide array of BU features, which could reduce or avoid salinity impacts, restore or replace degraded wetlands, create new terrestrial or marine habitat, and return sediment to the littoral zone. Table 2.5-2 lists all features that were considered and eliminated during preliminary screening and the reason for dropping them from further consideration. The incremental cost estimates presented in the table were developed during preliminary screening; they are based upon 2005 cost levels and use $2.05/gallon for marine diesel. Incremental costs are the additional costs that would be needed to use the material beneficially, over and above the normal costs of dredging and placement in designated PAs or ODMDSs. It is likely that the actual costs would be much higher than estimated here.

The feasibility of using new work and/or maintenance material was considered for all features. In the analysis for the inshore reaches, PA containment levee construction was the first priority for the use of new work material, followed by beneficial use opportunities. In the offshore reaches, opportunities for beneficial use of new work material were evaluated and eliminated before material was committed to existing and proposed ODMDSs. For maintenance material in both inshore and offshore reaches, priority was given to beneficial use if it could be demonstrated to be the least-cost alternative.

Table 2.5-2
Dredged Material Beneficial Use Features Eliminated from Consideration

Feature Description	Reason for Elimination
Hydrologic Restoration	
Marsh islands isolating Sabine-Neches Canal from Sabine Lake	Increased salinities in Black Bayou and up the Sabine River
Marshes constricting flow at mouth of Sabine Lake (north and south of SH 82 swing bridge)	Ineffective at reducing salinities Increases velocities through mouth of Sabine Lake
Marshes constricting flow along the side of the Port Arthur Canal	Ineffective at reducing salinities High cost relative to amount of marsh acres created
Construction of channel islands blocking flow from bayous emptying Neches River marshes at Rose City and Bessie Heights	Potential to cause backwater flooding Obstructed channel access for private landowners Navigation safety concerns
Filling canal at Texas Bayou using new work material from Sabine Pass Channel	Ineffective at reducing salinities because access still provided by Texas Bayou
Emergent Marsh Restoration	
Marsh restoration using new work material from Neches River Channel to restore marsh in Rose City West	Area is being developed as a mitigation bank; no longer available for restoration
Marsh restoration using new work material from Neches River Channel to restore marsh in Bessie Heights West	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $581K Sponsor has not been identified
Marsh restoration using new work material along the east shore of PAs 8 and 11 at Pleasure Island	Unacceptable location; interferes with levee maintenance
Marsh restoration at Old River Cove, east of power plant inflow channel, using new work material from the Neches River Channel	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $472K Sponsor has not been identified
Marsh restoration north of Keith Lake using maintenance material from Port Arthur Canal	Would be feasible but cost exceeds Base Plan Preliminary estimate of incremental cost – $300K Sponsor has not been identified
Marsh restoration in Texas Point NWR using new work material from Sabine Pass Channel to restore marsh behind subsided jetty section.	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $445K Sponsor has not been identified
Wildlife Habitat Creation	
Bird island constructed in Sabine Lake using new work material from Sabine-Neches Canal	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $1.9 million Sponsor has not been identified
Returning Sediment to Littoral Zone	
Texas or Louisiana Point shore nourishment using new work material from Section 5 of the Sabine Pass Channel	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $6.6 million Sponsor has not been identified
Texas or Louisiana Point shore nourishment using new work material from sections 5 and 6 of the Sabine Pass Channel	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $19.5 million Sponsor has not been identified
Stockpiling new work material from Extension channel for future beneficial use	Not feasible because material would disperse rapidly and not be available for use at a later date
Transporting sediment from new work dredging of the Extension Channel to the Texas or Louisiana littoral zone	Would be feasible but cost exceeds Traditional Placement Plan Preliminary estimate of incremental cost – $86.3 million Sponsor has not been identified
Marine Habitat Restoration	
Construction of topographic high in littoral zone with new work material	Topographic elevation would be temporary Incremental costs ($268 million) make it economically infeasible

Given the large amount of dredged material that would be generated with the proposed project, considerable effort was expended to identify areas that could benefit from its beneficial use. All degraded marsh areas near the SNWW were investigated to determine whether least-cost beneficial use features could be developed. No interior marsh areas in need of nourishment or restoration were identified adjacent to Sabine Pass in Louisiana. Areas in Louisiana that could benefit from beneficial use of dredged material are all located in the marshes east of Sabine Lake. However, these were found to be too distant from the navigation channel to permit cost-effective use of dredged material from the SNWW navigation channels. Numerous degraded marshes in Texas with potential for beneficial use were identified adjacent to the navigation channel. They are located in the Texas Point NWR adjacent to the Sabine Pass Channel, in the J.D. Murphree WMA adjacent to the Sabine-Neches Canal, and in areas of the Neches River WMA and private lands adjacent to the Neches River Channel. The Gulf shoreline at Texas and Louisiana Points is close enough to the navigation channel to allow cost-effective beneficial use of dredged material. The shoreline on the Texas side of Sabine Pass was also identified as a high priority area for beneficial use because of high ongoing erosion in this area.

Several hydrologic restoration features that were intended to prevent higher FWP salinities in portions of the study area were eliminated early in the screening process. They were modeled using the HS model and found to be either ineffective at reducing salinities or to have significant unintended impacts. For example, marsh islands constructed with new work material were proposed as a means of isolating the salinity wedge in the Sabine-Neches Canal from Sabine Lake. Modeling determined that the islands did block the flow into the lake, but forced a salinity wedge to travel up the Sabine River Channel, potentially affecting cypress-tupelo swamps in that watershed. Other proposed BU features that were unsuccessful in reducing salinities are described in Table 2.5-2.

A large number of conceptual designs for emergent marsh restoration throughout the study area were initially identified as possible compensatory mitigation measures. Because of their proximity to the navigation channel, several marsh restoration features in Texas were also evaluated to determine whether they would be less costly than traditional placement. Only the Neches River and Gulf Shore BU features were determined to be less costly than using upland PAs for new work (Traditional Placement Plan) or maintenance material (Base Plan). These features and the cost analysis are presented in detail later in this chapter. Marsh restoration features considered but eliminated included marsh restoration in Texas Point NWR using new work material from the Port Arthur Canal or the Sabine Pass Channel, and at Bessie Heights West using new work material from the Neches River Channel. Another feature used new work material for marsh restoration in the part of Old River Cove marsh that lies east of the intake canal. All were found to be feasible but more costly that traditional upland placement. The preliminary incremental costs for these features were relatively low, ranging from $300,000 to $581,000, but no sponsor has been identified to share the incremental cost.

The creation of new wildlife habitat using new work material from the Sabine-Neches Canal was also explored. This feature would provide needed nesting habitat for colonial waterbird species such as cormorant, pelican, heron, egret, spoonbill, gull, tern, and skimmer. These birds regularly nest in large numbers along the Texas and Louisiana coasts, frequently on bay islands, both natural and manmade.

Despite the presence of excellent waterbird habitat in the Sabine NWR, no colonies have been documented in Louisiana within the study area. The lack of isolated, predator-free islands is believed to be a primary cause for this lack of nesting habitat. It was proposed that an island be constructed in the middle of Sabine Lake with new work material from the Sabine-Neches Canal. This feature was eliminated when the cost was found to be approximately $2 million higher than the use of traditional upland PAs, and no sponsor was identified to share the incremental cost.

Several features were evaluated that would return sediment normally placed in upland PAs or ODMDSs to the littoral zone. Conceptual plans were developed for shore nourishment at Texas and Louisiana Points using new work material from Section 5 or sections 5 and 6 of the Sabine Pass Channel. The features were found to be feasible but cost $6.6 and $19.5 million, respectively, more than upland placement in PA 5. Stockpiling dredged material in ODMDS 4 for later use was also investigated. Like all other SNWW ODMDSs, material placed at this site disperses quickly after placement. Although it is closest to shore, the dispersed material in ODMDS 4 is not likely to migrate into the littoral zone because it is located beyond the depth of closure. It is expected that any material stockpiled within ODMDS 4 would be unavailable for use within 3 months of placement. Since stockpiling assumes that the beneficial use need will not be immediate or short term, it was concluded that this feature is not a viable alternative. Transporting and discharging coarser-grained sediments from the new work dredging of the Extension Channel (stations 117+000 to 146+000) into the littoral zone offshore of Texas or Louisiana Point was also evaluated. A hopper dredge with pump-out capability could be used to dredge the channel, move as close as possible to shore, and pump the material via a connecting pipeline to a discharge point within the 14-foot-depth contour. Discharging the material at or inshore of the depth of closure should guarantee the reintroduction of sediments within the littoral zone, where natural processes will beneficially distribute the sediments. It is estimated that the incremental cost of this action would be about $86.3 million. While feasible, this BU feature is much more costly than placement in the proposed ODMDSs B and C. No sponsor has been identified to share the incremental cost of the feasible BU features discussed above.

The creation of new marine habitat in the form of a "topographic high" offshore of Louisiana Point was also investigated. This feature would involve the beneficial use of new work material from the deepened Sabine Bank and Extension channels to create a new refuge or feeding locale for fish and shrimp. The material would be dredged as usual with a hopper dredge and then transported far enough upcurrent to prevent redeposition in the navigation channel. The material would be dropped in mounds forming a series of rows over a large area, roughly 2.0 by 2.5 miles. The actual ecological benefits of such a feature off the Texas coast have not been demonstrated. A similar feature was constructed outside of Galveston Bay, but no monitoring was conducted to determine whether any benefits accrued. In addition, the feature would be temporary because the dispersive processes acting on the ODMDSs would also be present here. It was eliminated from further consideration when it was estimated that the incremental cost of the temporary habitat would be approximately $268 million.

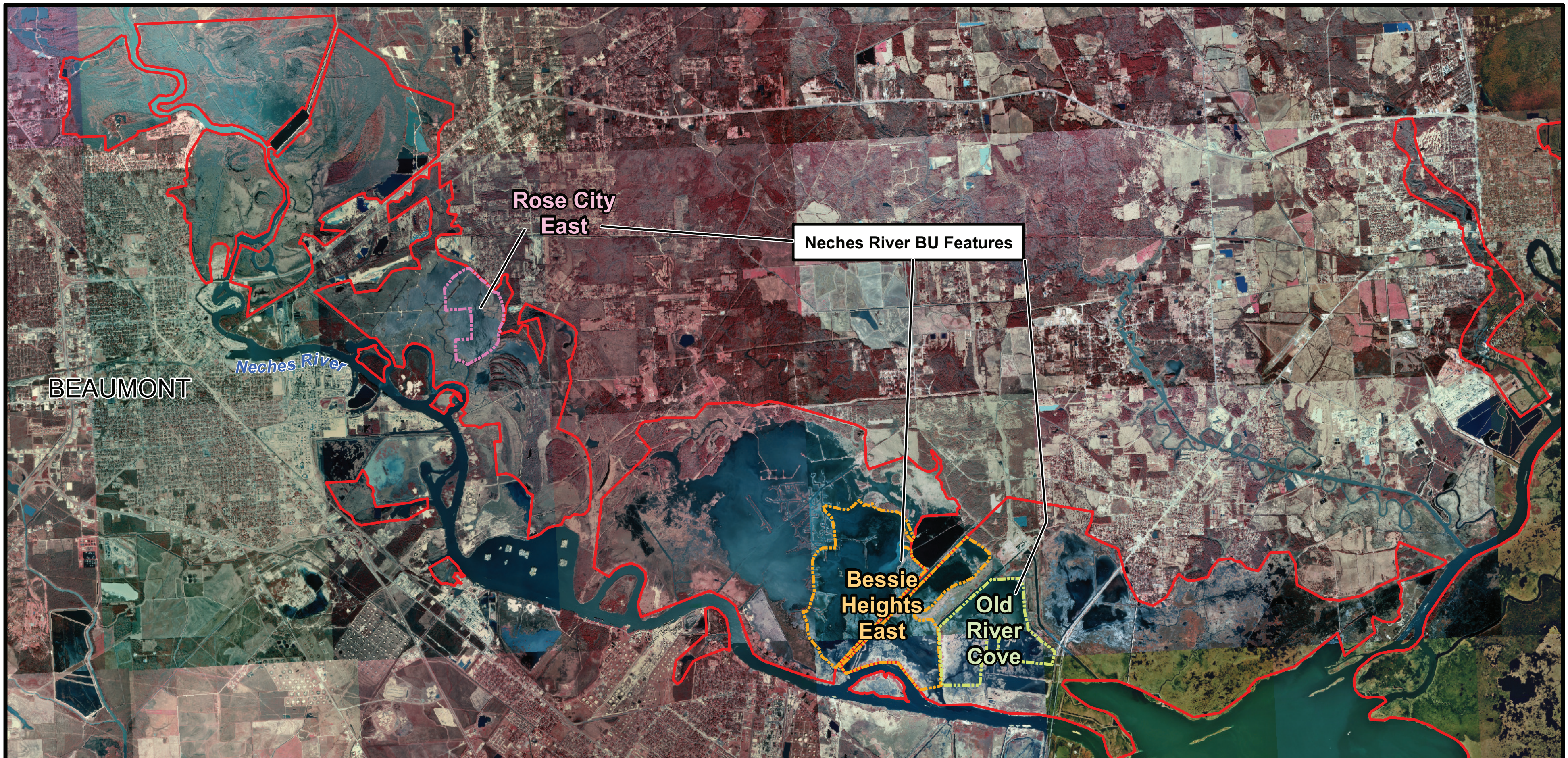
2.5.3.2 Detailed Evaluation of Disposal Features

After the preliminary screening, BU features that appeared to be least-cost alternatives for the beneficial use of dredged material in reducing with-project salinities, restoring marsh, or providing shoreline nourishment were advanced for detailed evaluation. Water and sediment sampling and bioaccumulation studies have established that dredged material from all SNWW navigation channels is suitable for beneficial use (PBS&J, 1999, 2002, 2004a). The ecological benefits of the following beneficial use features were evaluated and quantified using the WVA model, and these benefits were used to minimize project impacts as described below. A description of the WVA model is provided in Chapter 4. In addition, numerous existing upland PAs were evaluated for use with the Preferred Alternative. All BU alternatives to ODMDSs were eliminated during the preliminary screening. Existing and proposed ODMDS sites were therefore evaluated for the placement of all material from the offshore channel reaches.

2.5.3.2.1 Neches River BU Feature

Three former marsh areas on the Neches River have been combined into one large management feature, called the Neches River BU Feature (Figure 2.5-1), to provide flexibility in the use of new work and maintenance material from the several construction reaches of the Neches River Channel. The primary objective of this combination feature would be to beneficially utilize dredged material to restore emergent marsh in an area that has suffered dramatic, widespread loss of marsh. The BU feature would utilize new work and maintenance material that would otherwise be removed from the sediment system and stored in upland, confined placement areas.

The Neches River BU Feature would offset all indirect salinity impacts to Texas wetland habitats on the Neches and Sabine rivers (Hydrologic Units [HUs] TX 3 through TX 8, and TX 10 through TX 13) by restoring 2,853 acres of emergent marsh, improving 871 acres of shallow water by creating shallower ponds and interconnecting channels, and nourishing 1,234 acres of existing fringing marsh by winnowing fine-grained material from unconfined flows of dredged material effluent (Table 2.5-3). The BU feature thus provides benefits to a total of 4,958 acres of degraded marsh on the lower Neches River, or 53 percent of the restoration target set by the CEPRA 2004 plan update for the lower Neches River (GLO, 2004). The BU feature also offsets the direct impact of converting 86 acres of freshwater wetlands to a confined placement area (PA 24A). The size of the Neches River BU Feature components and the magnitude of their ecological benefits are made possible by the large amounts of dredged material that will be generated by the proposed project and extensive opportunities for beneficial use in the project area.



Rose City East
Bessie Heights East
Old River Cove
Hydrologic Unit

0 8,750 17,500
Feet

N
W E
S

Figure 2.5-1

Neches River

BU Feature

Prepared for: USACE
Job No.: 100007609
Scale: 1 inch equals 8,750 feet
Prepared by: 18827
Date: 08/10/2009

N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Figures/Fig_2_5_1.mxd

Table 2.5-3
Acreage Restored by Each Component of Neches River BU Feature

Components of the Neches River BU Feature	Restored Emergent Marsh	Improved Shallow-Water Habitat	Nourished Existing Marsh	Total Influence Area
Rose City East	345	72	151	568
Bessie Heights East	1,869	660	651	3,180
Old River Cove West	639	139	432	1,210
Total	2,853	871	1,234	4,958

2.5.3.2.2 Gulf Shore BU Feature

The use of dredged material was also evaluated for Gulf shoreline nourishment at Texas and Louisiana Points (Figure 2.5-2). Over the 50-year period of analysis, maintenance material would be hydraulically pumped from Section 5 of the adjacent Sabine Pass Channel onto a total of 6 miles of shoreline on both sides of Sabine Pass. Some material is expected to flow over existing marsh while the remainder will flow into nearshore waters. Material placement during each 3-year Sabine Pass Channel dredging cycle would alternate between Texas and Louisiana, so that material would be placed on each state's shoreline every 6 years. This recurring action would nourish eroding marsh, minimize projected FWP shoreline impacts, and potentially create new marsh. As this BU feature is located within the Texas Point NWR, USACE has requested that the USFWS prepare a compatibility determination for the proposed activity. See correspondence dated January 23, 2007, in Appendix A1 of the FEIS.

Texas Point is undergoing severe beach erosion, with shoreline retreat of up to 1,150 feet between 1974 and 2000 (King, 2007; Morang, 2006). This is the highest rate of shoreline loss on the upper Texas coast and a CEPRA "critical erosion area" (GLO, 2005). In Louisiana, persistent erosion along the shoreline between Ocean View and Holly Beach, on the order of –4.3 feet/year between 1985 and 1998, was recorded here prior to Hurricane Rita (USACE, 1971a, 2004a). Nearer to Louisiana Point, significant accretion over the last 100 years has slowed to +1.2 feet/year, and the behavior of this shoreline has become erratic, with some areas eroding and some aggrading (USACE, 2004a).

Historic dredging records indicate that the maintenance material from Sabine Pass will average 51 percent silt, 31 percent clay, and 18 percent fine sand (USACE dredging data base). This mix of materials does not contain typical beach-quality sand, but the material types and composition are similar to what is present on the shorelines today. Narrow beach fronts of silt or clay lie seaward of eroding overwash marsh terraces (PBS&J, 2006). Given the unusual characteristics of this sand-starved system, returning the material to the littoral system is likely to have a net beneficial effect, regardless of material type. The longshore transport in this system contains primarily fine-grained sediments, but these sediments have been shown to accumulate in the near shore zone and result in shoreline accretion by, as yet, poorly understood processes (King, 2007; Morang, 2006).

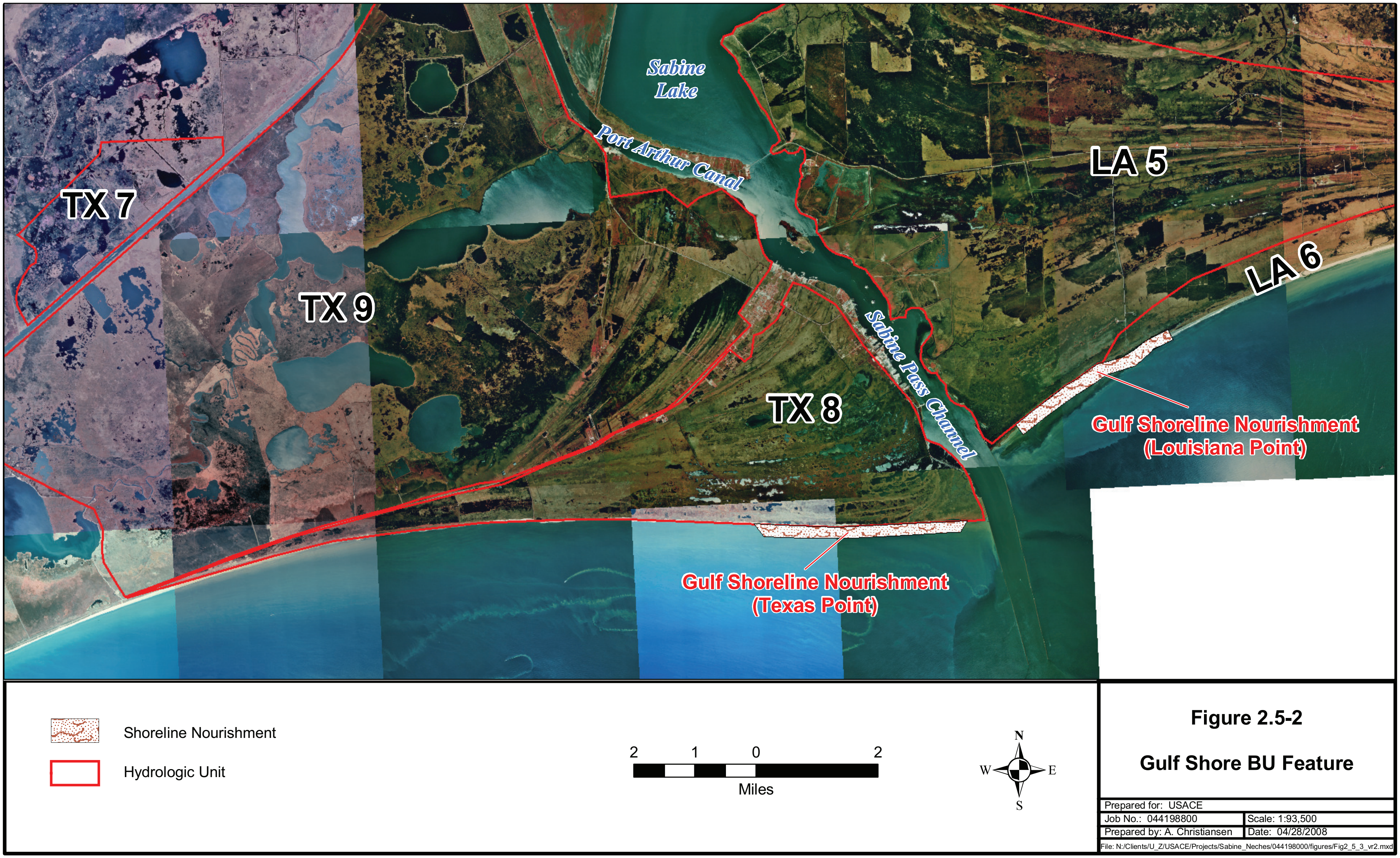


Figure 2.5-2

Gulf Shore BU Feature

Prepared for: USACE	
Job No.: 044198800	Scale: 1:93,500
Prepared by: A. Christiansen	Date: 04/28/2008

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/044198000/figures/Fig2_5_3_vr2.mxd

The Gulf Shore BU Feature will provide a regular source of predominantly fine-grained sediment that should contribute to mudflat accretion and periodically move onshore to become shore-attached through a process described by PIE (2003). On the western Louisiana and east Texas coasts, sediments accumulate as mudflats and underwater mudshoals (or “fluid mud”) in the nearshore region. Nearshore, fluid mud can be trapped against the shoreline by prevailing south and southwesterly winds, and storms carry the trapped muddy ooze onto the chenier shoreline. The northwest Gulf is a microtidal, storm-dominated environment. In a typical year there are about 20 to 30 frontal passages generating waves, surges, and wind-driven currents, with most frequent waves from the southeast about 3 to 4.5 feet in height (PIE, 2003).

Mudflat accretion on the western Louisiana coast appears to correlate with periods of high sediment influx from the Atchafalaya River and the passage of large storm systems. Up to 1,000 feet of accretion along a 4.5-mile segment of shoreline in western Louisiana occurred over a few days during the passage of Hurricane Aubrey (Morgan et al., 1958). Another study reports that accretion in western Louisiana occurs most frequently during storms and that it can be very rapid (Wells and Kemp, 1986). Huh et al. (1991) report that surge deposits of gel-like mud become stranded on the upper shoreface during storms. These deposits can dry and crack, forming mud cobbles that help to armor the shoreline. Fluid mud and mudflat accretion at the shoreline has also been observed on the Jefferson County shoreline. At Sea Rim State Beach in June 2002 (PIE, 2003), shoreline features were observed that resembled the storm surge deposits of fluid mud and mud cobbles reported above.

The presence of additional fine-grained sediments in the littoral system that will be provided by the BU feature should reduce the current erosion rate and minimize the small increase in shore erosion predicted with the project (Gravens and King, 2003). In systems that have an abundant supply of fine-grained sediments, the nearshore seabed can be blanketed with fluid mud. The presence of additional muddy sediment in the nearshore environment may attenuate waves and lessen wave-induced erosion (Hsiao and Shemdin, 1980; Tubman and Suhayda, 1976; Wells and Kemp, 1986). There are also anecdotal reports of Gulf areas off Louisiana and Texas Points being safe havens for vessels during storms due to the near-total attenuation of waves (Block, 1984; King, 2007; Wells and Kemp, 1986).

The BU dredged material is expected to be composed largely of unconsolidated muds. These fine-grained sediments are expected to initially be highly mobile and some portion of the material will be rapidly lost from the vicinity of the shoreline. As demonstrated by another BU project at Texas Point (USACE, 2000), a significant percentage will also flow onshore and nourish existing marsh along the eroding beachfront. Because of the prevailing wave climate, the mobile material within the surf zone should generally migrate to the west at both Texas and Louisiana Points (Wamsley, 2008). Transport processes identified by the Sabine Pass sediment budget (Morang, 2006) indicate that the material would move toward the eroding shoreline at Texas Point. There, the additional fine-grained sediments could lower erosion rates through the mudflat accretion and wave attenuation processes described above. A small quantity of material may migrate to the east and contribute to the Sabine fillet at the west jetty (King, 2007; Morang, 2006).

In Louisiana, the sand bar formed by BU sediments from the Cheniere LNG project may shelter the shoreline from wave energy sufficiently to allow fine-grained sediments to form a mudflat behind the sandbar (Nairn and Willis, 2002). While a significant percentage will be rapidly carried offshore, some is likely to move downcoast with the littoral current, enlarging the sand and mudflat already present at the east jetty. Potential impacts of elevated levels of total suspended solids (TSS) are expected to be similar to those that resulted from the Cheniere LNG BU project (PBS&J, 2004b). A temporary increase in suspended silt/clay was expected during the first 8 to 9 months following placement. After the termination of placement activities, TSS was expected to decrease for about 18 months when concentrations reached background levels. Modeling conducted for the Cheniere project indicated that it will take 9 years before the silt and clay component of Cheniere BU material become totally suspended and are removed from the littoral zone. Since the Gulf Shore BU Feature proposes a placement episode every 6 years, all the fine-grained sediments would not have been removed before new material is added. This should result in the retention of some portion of the fine-grained sediment, and thus facilitate mudflat accretion through the processes described above. During and after each placement episode, most of the resuspended silt and clay are expected to enter the Sabine Pass Jetty Channel through the shallow boat cut, but deposition in the channel is not expected. It should remain in suspension and be transported back into the Gulf.

Although the BU sediments will be largely fine grained, approximately 18 percent of maintenance material is expected to be sand. Sands that are deposited on shore will nourish and stabilize eroding marshes; sand deposited in the nearshore zone should stay in the nearshore environment, moving back and forth across the shoreface (Wamsley, 2008). Sand placed at Louisiana Point should remain on the shoreface where it was deposited; no significant amounts of sand are expected to enter the Jetty Channel. On erosive mud shorelines like those in the BU area, the sand percentage should increase and it will form sandy lenses or a veneer over the mud shoreline substrate. As the sand lenses thicken, the sands help protect the underlying mud from further erosion (Nairn, 1992). However, in smaller quantities, sand can also accelerate erosion of a mud beach. If the consolidated mud is not covered by a sand veneer, any sand that is mobilized by wave action will act as a scouring agent (King, 2007).

It is acknowledged that the behavior of the BU sediments within this complex littoral system cannot be predicted with certainty over the period of analysis, especially given the potential for strong storms to affect the coastal environment. However, there is sufficient knowledge of general processes and baseline conditions to support evaluation of potential impacts and benefits. Furthermore, the engineering feasibility and potential environmental benefits have been demonstrated by successful recent BU projects at Texas and Louisiana Points (PBS&J, 2004b; USACE, 2000). All of this information was used to establish explicit assumptions about the expected behavior of the BU material in the quantification of project impacts and benefits using the WVA model, as described in Appendix C of the FEIS. The WVA model analysis assumed that 60 percent of the pumped quantity will remain in the existing marsh and on the shallow nearshore slope in front of the existing shorefront immediately after material placement. Since the material is unconsolidated and prone to erosion, only 50 percent of that material was assumed to remain by the end of each 6-year cycle. It was further assumed that the regular addition of material every 6 years would slow the resuspension of fine sediments and result in the accumulation of some new marsh by the end of the period of analysis. No attempt was made to account for the effect of large storm systems. No long-term impacts to vegetation or benthic sediments were assumed to result from nourishment episodes. NWR personnel reported that the marsh vegetation at Texas Point rebounded quickly and with renewed vigour after being covered with up to 1 foot of material by the Texas Point BU project (Walther, 2005). Potential impacts to Critical Habitat for the wintering piping plover are expected to be beneficial in the long term, with short-term displacement during disposal activities. Benthic invertebrate fauna residing in the intertidal and tidal impact zones will be smothered, but studies have shown the impact to be similar to that resulting from natural events such as storms and hurricanes (Saloman and Naughton, 1977; Simon and Dauer, 1977). Following the burial, the resident species should recover quickly because of their short life cycle, high reproductive potential and the rapid recruitment of larvae and motile macrofauna from nearby unaffected areas (Nelson and Pullen, 1988).

2.5.3.3 Upland Placement Features

2.5.3.3.1 Existing Active PAs

Existing PAs were evaluated to determine whether they possessed sufficient capacity for new work and maintenance material over the 50-year period of analysis. All of the upland PAs were reviewed by the ICT for potential impacts to environmental resources, and no further environmental review was recommended for existing PAs that were in active use. Existing and proposed upland PAs are shown on figures 2.4-1d–g.

2.5.3.3.2 Existing Inactive PAs

Field visits were made to existing PAs that had been inactive in recent years (PAs 23A, 26, 27C, and 27D). Inactive PAs were visited to determine whether habitat and connectivity had developed since their last use such that they were contributing to the function of adjacent wetlands. No field visits or further review of new PA 18A and inactive PA 25A were recommended by the HW as they were known to contain low-quality, upland habitat. Observations made during the field visits are summarized below.

Existing PA 23A (269 acres) is a leveed upland area east of PA 23, covered by a secondary growth of tallow and black willow forest. Existing PA 26 (192 acres) is a leveed oxbow of the Neches River south of Rose City; it is covered primarily with cattail, phragmites, and palmetto in low spots and yaupon (*Ilex vomitoria*), privet, pine, and tallow on slightly higher elevations. Existing PA 27C (87 acres) is located on the upland west of Rose City, southwest of 27A and south of 27D. It is covered by a secondary upland forest of mixed loblolly pine (*Pinus taeda*), water oak (*Quercus nigra*), and sweetgum (*Liquidamber styraciflua*); most of the larger trees have been wind-thrown by recent storm events. Existing PA 27D (35 acres) is a leveed upland area adjacent to 27A. Its water table is kept artificially high by runoff from an adjacent industrial facility. This artificial water table supports dense California bulrush, fringed on the eastern side by a narrow corridor of second-growth cypress, sweetgum, and tallow. Both 27C and 27D are situated on the north side of the Neches River opposite the Beaumont Turning Basin. All of these areas have been modified extensively by past placement activities and associated levee systems that have artificially altered the hydrology. Surrounding levees hold water and isolate the areas from adjacent waterbodies, preventing them from contributing to the function of the adjacent wetlands and riparian corridor. All contain degraded habitat with low habitat values, primarily roosting habitat for birds and some wildlife cover. Renewed use of these areas would not constitute a significant adverse change to the existing environmental condition.

2.5.3.3.3 Areas Considered for PA Expansion

The quantities of dredged material projected for the Preferred Alternative necessitated additional PA capacity. Areas adjacent to existing PAs 14, 16, and 24 were evaluated to determine their suitability as PAs. The proposed expansion areas were designated as PAs 14A, 16A, 18A, and 24A. The HW evaluated these areas with aerial photographs and field inspections; descriptions and evaluations provided below were based upon those observations.

PA 14A (82 acres) is located south of existing PA 14, on the south side of the Neches River near its mouth. It is a relatively undisturbed wet meadow of marshhay cordgrass (*Spartina patens*) containing numerous small ponds. The area floods during seasonally high tides and heavy storms, providing intermittent hydrologic connectivity to the riparian corridor. It provides habitat for numerous native wildlife species and is covered by a valuable intermediate wetland. It was determined that use of this area would be a significant adverse change to existing conditions. The USACE reevaluated needs along the lower Neches River and dropped it from further consideration for use as a PA.

PA 16A (202 acres) is located west of existing PA 16 on the south side of the Neches River near its mouth. It is covered by intermediate marsh and crisscrossed by shallow streams and small ponds. It has never been leveed and receives tidal circulation through a natural bayou connecting to the Neches River and the Star Lake Canal, which forms its western boundary. Dominant wetland plants are marshhay cordgrass, several varieties of bulrush, cattail, and widgeon-grass (*Ruppia maritima*). The vegetation community and hydrologic connectivity to adjacent wetlands in the riparian corridor make this a high-quality native marsh providing important habitat for native fish and wildlife. The USACE determined that use of this area would be a significant adverse change to existing conditions. The EPA includes the 16A area in a preliminary area of concern for the Star Lake Canal Superfund Site (EPA, 2006). An EPA feasibility study to determine the nature and extent of contamination is under way. The area has been dropped from further consideration for use as a PA.

PA 18A (71 acres) is located north of existing PA 18. It is a disturbed upland area containing low-quality scrub habitat. Based upon HW review of an aerial photograph of the proposed expansion area and knowledge of the area, the area was determined to be suitable for use as a PA.

PA 24A (187 acres) is located north of the Maritime Administration's Reserve Fleet area. The area contains a central upland ridge with surrounding wetland components. The northern portion of the area is hydrologically connected to the Neches River, but hydrologic connections to the southern half of the site are restricted by prior levee and road construction. Wetlands in the area contain small open-water pockets but are primarily densely vegetated with California bulrush (*Scirpus californicus*), common reed (*Phragmites australis*), and marshhay cordgrass. Observed aquatic vegetation in shallow-water ditches includes common salvinia (*Salvinia minima*), water smartweed (*Polygonum hydropiperoides*), and white pond lily (*Nyphaea odorata*). Ninety-five percent of the overstory on the upland ridge is a secondary growth of invasive Chinese tallow (*Sapium sebiferum*) with occasional bald cypress (*Taxodium distichum*), red maple (*Acer rubra*), sweetgum, and American holly (*I. opaca*) composing about 5 percent of the overstory. The upland ridge is not hydrologically connected to adjacent riparian habitat and has very little mast forage. Wildlife value is limited to roosting habitat for birds and some wildlife cover. Wetlands in the northern portion and in swales surrounding the upland ridge are a higher quality fresh marsh habitat; the majority of the marshhay cordgrass wetland is located in the northern section. In order to minimize impacts to wetlands, the USACE redrew the proposed boundary of the PA to exclude 144 acres of the marshhay cordgrass in the northern section, reducing the proposed PA from 331 acres to 187 acres.

The proposed project's need for PA capacity in this reach of the SNWW requires that 86 acres of the lower quality wetlands in the southern portion of the area be converted to an upland PA. Impacts to the upland ridge would not constitute a significant adverse change to the existing environmental condition because of the low quality of that habitat. The conversion of 86 acres of freshwater wetlands to a confined PA is included in the predicted impacts of the Preferred Alternative. The WVA model quantified the loss of marsh function and acres due to this conversion as a loss of 32 AAHUs. The impact is fully offset by benefits of the DMMP Neches River BU Feature.

2.5.3.4 ODMDS Features

Four ODMDSs (Nos. 1–4, see Figure 2.4-1b) are currently in use for the existing SNWW project. Alternatives for the placement of new work material and the increase in maintenance material resulting from the construction of a deeper and longer offshore channel have been evaluated in an ODMDS Site Designation FEIS, which is included as Appendix B to this FEIS. Appendix B evaluates alternatives for the selection of new ODMDSs, including the use of the existing ODMDSs for the proposed CIP and beneficial use sites.

The existing ODMDSs were evaluated to determine whether they could accommodate all new work and maintenance material from the Preferred Alternative. Although it was determined that they were large enough to hold all the material, the 13.2-mile length of the channel extension would make the cost of hauling all new work and maintenance material to existing ODMDSs prohibitively expensive. Designation of four new ODMDSs (Nos. A–D, see Figure 2.4-1a) will be necessary. The best locations for the new sites were determined using the "zone of siting feasibility" screening technique, which delineates economically feasible sites that are sufficiently removed from ecologically sensitive or incompatible use areas to eliminate or minimize adverse impacts.

The ODMDSs FEIS found no significant environmental impacts related to the use of existing and proposed ODMDS sites for the SNWW Preferred Alternative. Analysis of northwestern Gulf circulation patterns confirmed that the existing and proposed ODMDSs were properly located on the west side of the navigation channel. Before- and after-dredging bathymetry surveys have demonstrated that the material placed offshore in the ODMDS does not accumulate; it disperses quickly after placement in the offshore environment.

The USACE and EPA have cooperated in the preparation of an FEIS for the proposed ODMDSs; this document is Appendix B of the FEIS. Public comment on the proposed ODMDSs was requested concurrently with comments on the SNWW CIP. If the FFR and FEIS are approved by the USACE and the Recommended Plan is authorized by the U.S. Congress, the EPA will publish a rule-making in the *Federal Register* that establishes SNWW ODMDSs A, B, C, and D for use in conjunction with construction and operation of the 48-foot project.

2.5.4 Incremental Environmental Impacts and Benefits of the DMMP

Incremental DMMP impacts of the proposed 48-foot project are discussed in detail in Section 4 of the FEIS, but are summarized here. The incremental impact consists of marsh lost with construction of one new upland placement cell (PA 24A), low-quality scrub habitat lost with the construction of another upland placement area (PA 18), and four new ODMDSs (A–D). No impacts are anticipated with improvements to existing upland PAs that are needed to provide additional capacity for the 50-year period of analysis, since improvements are limited to increasing containment levee heights. The DMMP BU features have net ecological benefits that are described below.

2.5.4.1 Methods and Objectives

The DMMP BU features described above provide ecological benefits, which offset project impacts. The benefits were used to reduce or minimize project impacts before remaining, unavoidable impacts were quantified, and compensating mitigation was developed. The WVA model was used to quantify impacts to all affected habitat types in the study area and establish the appropriate amount of offsetting DMMP benefits by habitat type. An HS model was used to evaluate and quantify salinity impacts and benefits of the BU plan. The WVA model is summarized in Section 5 and described in detail in Appendix C of the FEIS. The HS model is also summarized in Section 5, but it is described in detail in Brown and Stokes (2009). Evaluation of beneficial use alternatives was conducted within the ICT and technical workgroups in meetings conducted from 2001 to 2006. The BU plan was revised by the USACE in 2009 to reflect changes necessitated by project reformulation and revised HS modeling.

The DMMP benefits contribute to multiagency regional plans (the Texas Parks and Wildlife Department [TPWD] regional management plan for J.D. Murphree, Sea Rim State Park, Texas Point NWR, and McFaddin NWR, see Keith Lake: the Texas Coastwide Erosion Response Plan [GLO, 2004, 2005]; the Louisiana Comprehensive Management Plan [Louisiana Coastal Protection and Restoration Authority (LCPRA), 2007; USACE, 2008a]; the Louisiana Coast 2050 Plan [Louisiana Coastal Wetlands Conservation and Restoration Task Force and the Wetlands Conservation and Restoration Authority (LCWCR/WCRA), 1998], and the North American Waterfowl Management Plan [NAWMP Plan Committee, 2004]), by restoring and preserving scarce and vulnerable wetlands and wildlife habitat, nourishing eroding Gulf shorelines, restoring sediment to the littoral zone, and using dredged material beneficially to the greatest extent possible. The DMMP also complies with the Coastal Zone Management Plans (CZMP) for each state by sharing dredged material from the Sabine Pass Channel to accomplish regular shoreline nourishment. The Gulf Shore BU Feature shares this resource equally between the states because it is dredged from a channel that straddles the state boundary.

2.5.4.2 Offsetting and Minimizing Ecological Impacts

BU features included in the DMMP provide benefits that offset and minimize all indirect and direct impacts (–412 AAHUs) of the Preferred Alternative in Texas (Table 2.5-4) and partially offset impacts in Louisiana (Table 2.5-5). In Texas, construction of the Neches River BU Feature and the Texas portion of the Gulf Shore BU Feature will produce benefits totaling 1,068 AAHUs. Therefore, there will be a net gain of 656 AAHUs, which more than offsets all negative impacts that occur in Texas. Impacts that are offset include the direct loss of 32 AAHUs for the conversion of fresh marsh to upland PA 24A. The majority of the offset Texas impacts are in the Neches River watershed, but approximately 16 percent are losses to cypress-tupelo swamp (–22 AAHUs) and fresh and intermediate marsh (–45 AAHUs) in the Sabine River watershed. In Louisiana, the Gulf Shore BU Feature provides benefits totaling 210 AAHUs. Given total Louisiana impacts of 1,709 AAHUs, there is a net loss of 1,499 AAHUs remaining in Louisiana after offsetting benefits of the Louisiana portion of the Gulf Shore BU Feature are applied.

It is important to note that the impacts presented here do not include all impacts of the Preferred Alternative in Texas as FWP impacts in Texas's Salt Bayou (TX 9) hydro-unit are not included. Jefferson County, Texas, and USACE, with support from the TPWD, GLO, and Texas Water Development Board (TWDB) have been studying ways to reduce the amount of saltwater intrusion, decrease high-energy inflows, and minimize impacts to larval fish access in an ongoing Section 1135 Continuing Authorities Program (CAP) study for the Salt Bayou hydrologic unit. When the Keith Lake Section 1135 CAP study was begun in 2003, it seemed likely that the CAP study and construction would be completed before the SNWW CIP could be authorized and constructed. The Keith Lake Section 1135 study was therefore considered separable from the SNWW CIP, and for planning purposes, it was assumed that a water control structure at Fish Pass would be part of the future without-project condition for the SNWW CIP.

Incremental impacts of the SNWW CIP will be calculated for the Salt Bayou unit of the SNWW study area when WVA modeling is completed for the Keith Lake Section 1135 study. It is possible that the excess DMMP benefits (316 AAHUs) of the SNWW CIP will cover all incremental project impacts. However, if it is determined that additional mitigation is needed, then USACE and the non-Federal sponsor of the SNWW CIP will initiate consultation with resource agencies, identify and incrementally justify additional compensatory mitigation for the Salt Bayou unit, and prepare a supplemental environmental impact statement.

Table 2.5-4
Texas – FWP Impacts and Benefits by Habitat Type

		Offset Impacts by Acres and Habitat Type (acres)			Total Impacts/Benefits by Habitat Type (AAHUs)		
HU #	Hydrologic Unit (HU) Name	No Effect	Impacts Offset by BU Plan	Acres Impacted	Total Loss	Offsetting Benefits of BU Plan	Net FWP Benefit
Bottomland Hardwood							
Neches River Watershed							
TX 1	North Neches River	412					
TX 2	Neches-Lake Bayou	1,040					
TX 3	Rose City	1,775					
TX 5	Bessie Heights	293					
TX 6	Old River Cove	197					
	Subtotal - Neches River	**3,717**	**0**	**0**	**0**	**0**	**0**
Sabine River Watershed							
TX 10	Cow Bayou	388					
TX 11	Adams Bayou	640					
LA/TX 1	Sabine Island	524					
	Subtotal - Sabine River	**1,552**	**0**	**0**	**0**	**0**	**0**
	Total Bottomland Hardwood	**5,269**	**0**	**0**	**0**	**0**	**0**
Cypress/Tupelo Swamp							
Neches River Watershed							
TX 1	North Neches River	2,760					
TX 2	Neches-Lake Bayou	2,277					
TX 3	Rose City	464					
	Subtotal - Neches River	**5,501**			**0**	**0**	**0**
Sabine River Watershed							
TX 10	Cow Bayou	110					
TX 11	Adams Bayou			115	–4		–4
TX 12	Blue Elbow South			689	–18		–18
LA/TX 1	Sabine Island	1,194					
LA/TX 2	Blue Elbow	2,737					
	Subtotal - Sabine River	**4,041**	**0**	**804**	**–22**	**0**	**–22**
	Total Cypress/Tupelo Swamp	**9,542**	**0**	**804**	**–22**	**0**	**–22**
Fresh Marsh							
Neches River Watershed							
TX 1	North Neches River	436					
TX 2	Neches-Lake Bayou	1,535					
TX 3	*Rose City PA 24A**			86	–32		–32
TX 3	Rose City			3,241	–1	178	177
TX 4	West of Rose City	492					
TX 5	Bessie Heights	2,147					
TX 7	GIWW North			4,806	–140		–140
	Subtotal - Neches River	**4,610**	**0**	**8,133**	**–173**	**178**	**5**
Sabine River Watershed							
TX 10	Cow Bayou			1,775	–18		–18
TX 11	Adams Bayou			599	–15		–15
	Subtotal - Sabine River	**0**	**0**	**2,374**	**–33**	**0**	**–33**
	Total Fresh Marsh	**4,610**	**0**	**10,507**	**–206**	**178**	**–28**

Table 2.5-4, cont'd

		Offset Impacts by Acres and Habitat Type (acres)			Total Impacts/Benefits by Habitat Type (AAHUs)		
HU #	Hydrologic Unit (HU) Name	No Effect	Impacts Offset by BU Plan	Acres Impacted	Total Loss	Offsetting Benefits of BU Plan	Net FWP Benefit
Intermediate Marsh							
Neches River Watershed							
TX 5	Bessie Heights			6,933	–14	433	419
TX 8	Texas Point			1,742	–19		-19
TX 13	Groves			437	–3		-3
	Subtotal – Neches River	**0**	**0**	**9,112**	**–36**	**433**	**397**
Sabine River Watershed							
TX 10	Cow Bayou			1,144	–12		-12
	Subtotal – Sabine River	**0**	**0**	**1,144**	**–12**	**0**	**-12**
	Total Intermediate Marsh	**0**	**0**	**10,256**	**–48**	**433**	**385**
Brackish Marsh							
Neches River Watershed							
TX 6	Old River Cove			8,760	–116	235	119
TX 8	Texas Point			2,546	–7		-7
TX 7	GIWW North			647	–8		-8
	Subtotal – Neches River	**0**	**0**	**11,953**	**–131**	**235**	**104**
	Total Brackish Marsh	**0**	**0**	**11,953**	**–131**	**235**	**104**
Saline Marsh							
Neches River Watershed							
TX 8	Texas Point		5,708		–5	222	217
	Subtotal – Neches River		**5,708**		**–5**	**222**	**217**
	Total Saline Marsh	**0**	**5,708**	**0**	**–5**	**222**	**217**
Total Neches River Impacts		13,828	5,708	29,198	–345	1,068	723
Total Sabine River Impacts		5,593	0	4,322	–67	0	–67
Total - All Habitats		**19,421**	**5,708**	**33,520**	**–412**	**1,068**	**656**

*Direct impact associated with conversion of wetland to upland PA 24A.

Table 2.5-5
Louisiana – FWP Impacts by and Benefits Habitat Type

HU #	Hydrologic Unit (HU) Name	Offset Impacts by Acres and Habitat Type (acres): No Impact	Offset Impacts by Acres and Habitat Type (acres): Impacts Offset by BU Plan	Offset Impacts by Acres and Habitat Type (acres): Acres Impacted	Total Impacts/Benefits by Habitat Type (AAHUs): Total Loss	Total Impacts/Benefits by Habitat Type (AAHUs): Offsetting Benefits of BU Plan	Total Impacts/Benefits by Habitat Type (AAHUs): Net FWP Impact
All HUs in Sabine River Watershed							
Bottomland Hardwood							
LA 1	Perry Ridge	2,158					
LA/TX 1	Sabine Island	1,041					
	Subtotal	3,199			0		0
Cypress/Tupelo Swamp							
LA/TX 1	Sabine Island	5,998					
LA/TX 2	Blue Elbow	650					
	Subtotal	6,648			0		0
Fresh Marsh							
LA 1	Perry Ridge			18,859	–65		–65
LA 7	Southeast Sabine			2,634	–11		–11
LA 8	Southwest Gum Cove			3,615	–2		–2
	Subtotal			25,108	–78		–78
Intermediate Marsh							
LA 1	Perry Ridge			4,704	–53		–53
LA 2	Willow Bayou			35,109	–328		–328
LA 3	Black Bayou			34,941	–509		–509
LA 4	West Johnson's Bayou			11,110	–269		–269
LA 5	Sabine Lake Ridges			9,270	–218		–218
LA 7	Southeast Sabine	5,400					
LA 8	Southwest Gum Cove			6,605	–4		–4
LA 9	East Johnson's Bayou			26,138	–190		–190
	Subtotal	5,400		127,877	–1,571		–1,571
Brackish Marsh							
LA 2	Willow Bayou			1,182	–1		–1
LA 3	Black Bayou			3,195	–1		–1
LA 4	West Johnson's Bayou			2,078	–1		–1
LA 5	Sabine Lake Ridges			15,962	–14		–14
LA 6	Johnson's Bayou Ridge			2,744	–6		–6
	Subtotal			25,161	–23		–23
Saline Marsh							
LA 5	Sabine Lake Ridges		3,767		–35	210	173
LA 6	Johnson's Bayou Ridge		370		–2		
	Subtotal		4,137		–37	210	173
	Louisiana Impacts Total	**15,247**	**4,137**	**178,146**	**–1,709**	**210**	**–1,499**

With adoption of the DMMP, all FWP impacts in Texas will be offset, and no compensating mitigation is proposed in conjunction with construction of the Preferred Alternative. Impacts in Louisiana are minimized to the greatest extent possible by the DMMP, but unavoidable impacts of –1,499 AAHUs remain. When the impacts and DMMP benefits are not subdivided by state but are applied to the project as a whole, a loss of 843 AAHUs remains (Table 2.5-6). A mitigation plan, described in Section 5, has been developed to compensate for unavoidable impacts of the Preferred Alternative.

Table 2.5-6
Net FWP Impacts (AAHUs) for Project as a Whole

	Bottomland Hardwood	Cypress-Tupelo Swamp	Fresh Marsh	Intermediate Marsh	Brackish Marsh	Saline Marsh	Total
Impacts							
Texas							
Neches River watershed			–173	–36	–131	–5	–345
Sabine River watershed		–22	–33	–12			–67
Subtotal	0	–22	–206	–48	–131	–5	–412
Louisiana							
Sabine River watershed			–90	–1,571	–23	–37	–1,709
Total Impacts	0	–22	–296	–1,619	–154	–42	–2,121
DMMP Benefits							
Texas							
Neches River watershed							
Neches River BU Feature			178	305	363		846
Gulf Shore BU Feature (Texas Point)						222	222
Subtotal	0	0	178	305	363	222	1,068
Louisiana							
Sabine River watershed							
Gulf Shore BU Feature (Louisiana Point)						210	210
Total DMMP Benefits	0	0	178	305	363	432	1,278
Net SNWW CIP FWP Impacts							
Texas							
Neches River watershed			5	269	232	217	723
Sabine River watershed		–22	–33	–12			–67
Net Texas Benefits (positive)							656
Net Louisiana Impacts (negative)	0	0	–90	–1,571	–23	173	–1,499
Net FWP Impacts	0	–22	–118	–1,314	209	390	–843

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3.0 AFFECTED ENVIRONMENT

This chapter is divided into 14 sections. Section 3.1 describes the models that were used to characterize existing conditions, and evaluate impacts as presented in Section 4. A description of the environmental setting follows in Section 3.2, followed by separate sections on the physical, natural, cultural, and socioeconomic resources in the SNWW study area that could be affected by the proposed project.

3.1 MODELING EXISTING CONDITIONS

Since the primary environmental concerns identified during the scoping process are the interrelated issues of saltwater intrusion, marsh loss, and destruction of wildlife habitat and fishery nursery areas, engineering and ecological models were used to characterize existing conditions related to these concerns, thereby establishing a baseline against which changes associated with project alternatives could be measured. Several engineering models were used to evaluate physical systems and processes in the study area, and an ecological model was used to evaluate the biological effects of project alternatives on habitat.

3.1.1 Hydrodynamic Salinity

Concerns that a deeper navigation channel would increase salinity in the Sabine Lake estuarine system were addressed with a 3-dimensional HS model that predicts changes in salinity, circulation, and water elevation due to proposed channel improvements. The ERDC's Coastal and Hydraulics Laboratory (CHL) worked closely with the ICT to calibrate and verify the base model for use in this system. The ICT reviewed the ERDC's model calibration and verification process, provided data and information on hydrologic connectivity, marsh elevation, and bathymetry, and reviewed modeling results as part of the impacts evaluation. For the baseline conditions, modeling was performed using actual depths rather than authorized project depths.

The ERDC's CHL applied an established 3-dimensional estuarine model (ERDC-modified TABS Multi-Dimensional Numerical Modeling System) to compute hydrodynamics and salinity transport for the proposed CIP. The HS model covers the entire study area from the Salt Bayou watershed on the west to near Gum Cove Ridge in Louisiana on the east, and inland to north of IH 10. The model includes forcing due to tides, freshwater inflows, wind, Coriolis, and density gradients due to salinity variation, and accounts for precipitation and evaporation. The code uses a finite-element formulation, which gives it flexibility in matching complex geometry. Over the last decade, the code has been extensively used for a variety of the USACE field projects, including the Houston-Galveston Navigation Channels project, New York Harbor, St. Johns River, Florida, and Atchafalaya Bay in Louisiana. Two of the special features of the code, wetting/drying and "marsh porosity," enable successful modeling of wetlands. A description of the model and its output is provided in a report by the ERDC-CHL (Brown and Stokes, 2009).

HS model salinities were verified against salinity data from June to December 2001. The modeling report provided standard deviations for each of the original modeling stations; these provide a measure of the uncertainty inherent in the model predictions. For the baseline condition, model outputs were provided for all original sampling locations.

3.1.2 Other Engineering Models

Several other engineering models were conducted to characterize other existing physical processes in the study area, and to provide baseline information for the assessment of impacts. The most significant of these are:

Ship Simulation. The ship simulation was used to determine navigation and safety impacts due to anticipated changes in vessel sizes as a result of the proposed channel widening (Webb, 2003). The main objective of the study was to determine whether the "design" ship could safely operate within the width and depth of the proposed channel dimensions. The simulation was conducted on a channel depth of 50 feet with varying widths. Additional ship simulation was conducted to determine the navigation and safety implications of reducing the offshore entrance channel to a 700-foot width.

Sediment Study. A desktop engineering model was applied to determine anticipated shoaling rates along the waterway and estimate any increases in channel erosion (Brown and Stokes, 2009; Parchure et al., 2005). Results from the study were used to estimate the quantity of maintenance material arising from structural alternatives. Erosion concerns along Pleasure Island and East Sabine Lake were also addressed by the analysis. An additional study effort was performed along the Pleasure Island reach and Sabine-Neches Canal to determine whether the channel velocities in these areas would result in increased channel erosion.

Vessel Effects Study. A vessel effects study was conducted to determine the potential erosional effects to Pleasure Island from vessel traffic in the Port Arthur and Sabine-Neches canals (Maynord, 2005). Project vessel traffic was modeled with HIVEL2D, a two-dimensional finite element model designed specifically to simulate flow in typical high-velocity channels. The model has been used since the mid-1980s and is maintained by the ERDC-CHL.

Gulf Shoreline Effects Study. This ERDC-CHL study was conducted to determine potential erosion impacts to the Gulf shoreline that could be associated with deepening and extending the Entrance Channel. The study area extended 10 miles from the jetties into Texas and Louisiana (Gravens and King, 2003). The STWAVE and GENESIS models were applied to examine wave conditions within a bathymetry grid extending 20 miles along the shoreline and evaluate changes to the shoreline.

3.1.3 Wetland Value Assessment Model

The WVA model suite uses a quantitative habitat-based assessment methodology developed to prioritize Louisiana coastal restoration projects submitted for funding under Coastal Wetlands Planning, Protection and Restoration Act (CWPPRA) (Louis Berger Group and Toxicological & Environmental Associates [LBG and TEA], 2008). The WVA model is a modification of the widely used Habitat Evaluation Procedure (HEP) models developed by the USFWS (1980). It was developed by the Environmental Workgroup (EnvWG) of the Planning and Evaluation Subcommittee of Louisiana's CWPPRA Technical Committee (USFWS, 2002a). The WVA methodology employs a community approach that assumes that optimal conditions for all fish and wildlife within a specific type of coastal wetland habitat can be characterized by a group of significant variables, and that existing or future conditions can be compared to that optimum, providing an index of habitat quality similar to those developed under the well-established HEP. Using this methodology, several habitat-specific community models have been developed by the EnvWG, and three were selected for use in this study: the Emergent Marsh Community Model (EMCM), the Swamp Community Model (SCM), and the Bottomland Hardwood Model (BHM). The EMCM can be applied to four coastal marsh communities—fresh, intermediate, brackish, and saline marsh. Hereafter in this report, the term "WVA model" applies to the three components of the WVA model suite (EMCM, SCM, and BHM) that are used in this study. The results of the WVA model, measured in AAHUs, can be combined with cost data to provide a measure of the effectiveness of the proposed project in terms of annualized cost per AAHUs gained.

A WVA Procedural Manual was prepared by the EnvWG to provide guidance in the use of the WVA model (USFWS, 2002b). In addition, a separate procedural manual was prepared for the EMCM (USFWS, 2002c). The BHM and the SCM (LDNR, 1993) were developed outside of the CWPPRA arena and are periodically used by the EnvWG for CWPPRA project evaluation. The original BHM (LDNR, 1993) was utilized for this study. The SCM was subsequently updated by the EnvWG and the updated version was used here (USFWS, 2002d). The SNWW Habitat Workgroup chose to apply the WVA model as formulated by the EnvWG and LDNR because the habitats and environmental stressors in the SNWW study area are the same as those for which they were developed. Appendix C of the FEIS maps and characterizes all significant habitats in the study area, explains how the WVA model evaluates project impacts and benefits, and describes the methods and assumptions used in the modeling process.

The WVA model provides a comprehensive, quantitative measure of FWP changes in the quality and quantity of emergent wetlands and associated aquatic habitat in the SNWW study. However, it was not developed for use in conjunction with aquatic habitats in large waterbodies. Baseline conditions for aquatic habitats in the SNWW study area that are not associated with emergent wetlands were not characterized with the WVA model or any other ecological model. It was determined that use of an ecological model to characterize and evaluate impacts for these resources would not be necessary, due to the nature of the impacts and conditions specific to the study area; more information relative to this decision is presented in Section 4. However, aquatic habitats in the Sabine and Neches rivers, Sabine Lake, the SNWW and GIWW navigation channels, and offshore in the Gulf are described in this section to the extent necessary to compare to FWP alternatives.

The WVA model was chosen as the most appropriate ecological model for the SNWW project based on a number of factors. Although the WVA model was developed specifically to apply to habitat types present in the Chenier Plain region of the Louisiana coastal zone, the same types of coastal habitat (emergent coastal marsh, bottomland hardwoods, and cypress-tupelo swamp) are present throughout the Sabine-Neches coastal watershed in both Texas and Louisiana, and in fact are a continuation of the same system (Daigle et al., 2006; Griffith et al., 2004). In addition, the areas contain the same fish and wildlife communities, similar soils, and topography, and the Sabine-Calcasieu basins share an interconnected hydrology. Furthermore, the types of variables measured by the WVA model are sensitive to the types of changes that have been identified as the highest concerns by resource agencies and the general public for the SNWW project. Specifically, these are potential changes in salinity, stress and death of marsh vegetation, and further loss or degradation of already stressed coastal marshes. The variables measured by the WVA model are also recognized scientifically and technically as important in characterizing overall habitat quality. Variables utilized in the WVA model outputs could be combined across the different habitat types. A final factor is that variables were established such that data were easily estimated or collected from existing data sources. This was especially important because the study area is exceptionally large (over 2,000 square miles), and therefore extensive field data collection efforts were not practical. The size and habitat diversity of the study area made application of other ecological models very difficult. Other ecological models, such as the Hydrogeomorphic Approach and HEP models, were considered and rejected because extensive field data collection required by these models was not feasible given time and budget constraints.

An ICT was established that (1) identified environmental issues and concerns; (2) evaluated the significance of fish and wildlife and other ecosystem features; (3) recommended and reviewed environmental studies; (4) evaluated potential impacts; and (5) recommended and evaluated potential mitigation measures. The ICT defined the study area as all areas possibly affected by the proposed project. Potential environmental effects in adjacent coastal wetlands were analyzed for an extensive area including Sabine Lake and adjacent marshes in Texas and Louisiana, the Neches River Channel up to the new Neches River Saltwater Barrier, the Sabine River Channel to the Sabine Island WMA, the GIWW west to Star Bayou, the GIWW east to Gum Cove Ridge, the Gulf shoreline extending 10 miles either side of Sabine Pass, and offshore in the Gulf, 15 miles beyond the end of the current channel.

A subcommittee of the ICT, the HW, developed input data and applied the WVA model. The subcommittee analysis provided data on baseline and FWOP conditions and, as explained later in this document, project impacts and mitigation for specific areas. The use of the WVA model and other information provided by the ICT produced a great amount of detailed data regarding the existing and potential future conditions of the study area. This information is included in this chapter's description of the affected environment.

The WVA model created vegetation categories and mapping units in order to describe baseline or existing conditions and predict future conditions with and without the proposed project under various scenarios including various possible mitigation projects. All habitats hydrologically connected to waterways influenced by the proposed channel improvements were divided into "Hydrologic Units" (hydro-units). Hydro-unit boundaries were based upon small watershed divides, or on the basis of other topographic features that serve as hydrologic separators. Vegetation categories were mapped within each of these hydro-units. The WVA methodology for determining the vegetation baseline is briefly described below. Section 4.1 describes the modeling methodology for determining impacts and mitigation plans. See Appendix C for the detailed methodology.

FWOP projections of land loss were developed as a baseline against which project-induced changes could be measured. Base land loss rates were determined by measuring changes of emergent marsh and open-water areas using Geographic Information System (GIS) software between images from 2 or more years.

The time between images generally spanned the most recent 15- to 20-year time period for which reliable data were available. This time period generally fell between the years 1978 and 2001.

After changes in acreages were calculated, the amount of emergent marsh that converted to open water was expressed as a percentage loss per year. Adjustments to FWOP land loss rates were made to account for constructed or funded CWPPRA projects in the east Sabine Lake marshes (Clark et al., 2000; USFWS and Natural Resources Conservation Service [NRCS], 2003), at Black Bayou (LDNR, 1993), and at Perry Ridge (USGS-National Wetlands Research Center [NWRC], 2002a, 2002b), the effects of RSLR on shoreline recession, and RSLR, as described in Appendix C of this FEIS. A spreadsheet that calculates land loss annually was used for all projections.

The WVA model has been assessed for use in conjunction with the SNWW project, as required by EC 1105-2-407. The WVA model is not a USACE corporate model, and therefore certification is not required, but the model must be approved for use. This approval was provided by the Deep-Draft Center for Expertise based upon the results of a model assessment (LBG and TEA, 2008). The assessment evaluated the application of the three WVA model components (EMCM, SCM, and BHM) that were used to quantify impacts and benefits of SNWW CIP alternatives, including BU features and compensatory mitigation. The assessment determined that the model was theoretically appropriate and correctly applied, and it has been approved for use for the SNWW study.

3.2 ENVIRONMENTAL SETTING

3.2.1 Study Area

The SNWW is located in Jefferson and Orange counties in southeast Texas, and Cameron and Calcasieu parishes in southwest Louisiana. The project area includes the SNWW from the Gulf through the jettied channel at Sabine Pass, through the Port Arthur Canal, Sabine-Neches Canal, and Neches River Channel to the Port of Beaumont. Included is the area covered by the possible addition of 13.2 miles of new channel extending beyond the end of the existing channel into the Gulf. The Sabine River Channel, which extends from the mouth of the Neches River to the Port of Orange, is not currently being considered for channel modification and is not addressed in this FEIS.

The study area includes the SNWW and a much broader geographical range covering approximately 2,000 square miles inland. Due to potential additional saltwater intrusion into the Sabine Lake estuary resulting from the CIP, hydrologic features associated with the SNWW and Sabine Lake are an important consideration. In addition, beneficial use of dredged material may include efforts outside of existing PAs and may include areas well outside of the SNWW.

3.2.2 Physiography

The study area is located in the Austroriparian Biotic Province (Blair, 1950), which extends from east Texas along the Gulf Coast plain to the Atlantic coast, and the Outer Coastal Plain Mixed Forest Physiographic Province (McNab and Avers, 1994). The study area is characterized by a diversity of features that are a result of the natural transition between marine and freshwater environments and anthropogenic impacts. The Sabine and Neches rivers consist of flat to gently rolling surface topography with poorly drained floodplains that include dense bottomland forests with extensive complexes of interconnecting coastal prairie, wetlands, and bayous. Farmers and ranchers are the principal users of these prairie and upper marsh areas. Developable uplands are mostly restricted to the west side of the estuary. All of the cities and towns in the study area are located in Texas on the west side of Sabine Pass, Sabine Lake, and upland areas north of Sabine Lake. The timberlands in the flood-prone areas are used primarily as wildlife habitat with some areas commercially lumbered on a small scale. The topography of the study area is essentially featureless, except for the surface expression of four salt domes: Big Hill, Fannett, and Spindletop, Texas, and Hackberry, Louisiana. This area once supported major petroleum reserves, but now only produces limited quantities of oil and gas (USACE, 1982).

Aten (1983:15–20) provides the following description of the northwestern Gulf coast that gives a good description of the study area as well:

> . . .[this area] strikes many visitors as a monotonous repetition of prairies and marshes interspersed with an occasional swamp, barrier beach, or forest. . . . it is a highly dynamic environment that has taken on much of its present form concurrent with human occupation. . . . The basic genesis of the coastal zone land surfaces is that of a series of major river deltas coalesced into an extensive and continuous deltaic plain during the Late Pleistocene. Superimposed on this massive accumulation of deltaic material . . . are the effects of more recent events, such as Late Pleistocene-Holocene sea level fall and rise, and the formation of the modern river deltas, estuaries, . . .
>
> . . . Inland . . . are sandier and slightly rolling terrains . . . [that] support pine and hardwood forests. . . .
>
> . . . The major natural hazard in the area is flooding, which results either from overflow in rivers or from storm tides . . . the tidally influenced waters of the estuaries and streams supported [prehistorically] enormous populations of shellfish, fish, birds, reptiles, and mammals . . . over 125 animal taxa have been recovered archaeologically as food remains. . . .

Due to the abundance of rainfall in this region, the rivers and bayous of this reach provide substantial freshwater inflow into Sabine Lake. However, instream flows to this reach have been altered from their natural hydrograph due to major impoundments in the middle and upper Sabine and Neches River basins. Similar to Aten's (1983) description of the region, most of the Sabine and Neches rivers reach is tidally influenced (Mantz and Dong, 1996). Despite abundant rainfall, navigational dredging has allowed saltwater intrusion into these rivers and bayous (USACE, 1998a) resulting in saltwater wedges typically overlaid with influent fresh water.

The Sabine Lake area is a dynamic estuary only recently subject to extensive flood and ebbs of tidal currents and extensive mixing of fresh and sea water. Sabine Lake was formed from the flooding of an ancient river valley (Kane, 1959) and was later separated from the Gulf by the advancement of the Gulf shoreline and deposition of the beach ridge/mudflat complex known as the Chenier Plain (Gould and McFarlan, 1959). High-volume freshwater inflow into Sabine Lake helped maintain Sabine Pass as a narrow and relatively shallow link between the Gulf and Sabine Lake (Morton, 1996).

The Gulf in the study area consists of open seas, coastline, and a dredged channel extending from the jettied Sabine Pass seaward. This area is dominated by the Mississippi River Delta. When the Mississippi River occupied one of its western courses, sediment deposits were carried westward by littoral currents that built the Chenier Plain (Davis, 1996). Since the Mississippi River has been emptying through its eastern delta lobe, little new sediment has been reaching the Chenier Plain (USACE, 1975a).

3.2.3 Geology

The regional surface geology of the Gulf Coast region consists of sedimentary beds ranging in age from late Eocene to recent, which lie as bands nearly parallel with the coast. Recent deposits form the coastline and successive beds crop out toward the interior. Due to the age of exposure of the rocks, the outcrop areas are successively more eroded and dissected toward the interior. The Pleistocene and Recent formations still retain much of their depositional surface (Texas Water Commission, 1963).

The thick sequence of sedimentary rocks and unconsolidated sediments beneath the present-day Gulf Coastal Plain reflect cyclic marine and continental deposition in the region through the Jurassic, Cretaceous, and Tertiary periods, culminating with predominantly fluvial deposits at the end of the Tertiary period. This pattern continued through the Pleistocene Epoch (i.e., early Quaternary period, about 2 million years before present), during which sedimentation was largely controlled by sea level fluctuations associated with repeated glacial and interglacial episodes (Van Siclen, 1975). During the Holocene, the fluvial Sabine Valley became an estuarine system, eventually becoming completely inundated by the rising sea level. During this interval, an estuarine-lagoonal system became dominant (Pearson et al., 1986).

The primary physiographic environments of the study area consist of two major Pleistocene depositional systems and five major Holocene depositional systems. The major Pleistocene systems include the fluvial-deltaic systems and barrier-strandplain systems. These two systems form the Coastal Zone within the study area, generally at elevations greater than 10 feet above sea level (Brown et al., 1973). The five major Holocene depositional systems include the fluvial systems, strandplain-chenier systems, offshore systems, marsh-swamp systems, and bay-estuary-lagoon systems. The Coastal Zone is underlain by sedimentary deposits that originated in ancient but similar physiographic environments. These ancient sediments were deposited by the same natural processes that are currently active in shaping the present coastline. These processes include longshore drift, beach wash, wind deflation and deposition, tidal currents, wind-generated waves and currents, and levee, point-bar, and flood basin deposition (Brown et al., 1973).

The Quaternary-aged Beaumont Formation covers the entire inland study area and is overlain by the younger Deweyville Formation and Alluvium within the Neches and Sabine River valleys. Quaternary

Alluvium and isolated barrier island deposits outcrop along the coastline. The environments responsible for the deposition of the Beaumont Formation primarily include stream channel, point bar, natural levee, backswamp, and coastal marsh and mudflat deposits. The Beaumont Formation is composed of clay with interbedded silt and sand. Similarly, the environments responsible for the deposition of the Quaternary-aged Deweyville Formation include point bar, natural levee, stream channel, and backswamp deposits. The Deweyville Formation is composed of sand, silt, and clay, with some gravel. The Quaternary Alluvium, which is found immediately adjacent to existing river courses and along the Gulf Coast shore, was deposited primarily in point bar, natural levee, stream channel, backswamp, coastal marsh, mudflat, and narrow beach deposits and is composed of clay, silt, and locally abundant organic matter (Bureau of Economic Geology [BEG], 1982).

3.2.4 Climate

The climate of the study area is both tropical and temperate (Soil Conservation Service, 1965). Prevailing winds are generally from the south and southeast with an average speed of about 10 to 11 miles per hour. In the winter months, cold air masses bring in polar air and prevailing northerly winds. Temperatures are moderated by the influence of the winds from the Gulf, resulting in mild winters and relatively cool summer nights. The mean daily temperature ranges from the mid-50s (degrees Fahrenheit [°F]) in December and January to the mid-80s in the summer months. The temperature rarely drops below 22°F or rises above 98°F. Relative humidity levels average approximately 78 percent throughout the year (USACE, 1975a). Another effect of the nearness of the Gulf is abundant rainfall distributed throughout the year. The average annual rainfall is about 52 inches, with monthly precipitation averaging from 3.2 inches to about 6.6 inches. Snow and sleet seldom occur. Heavy fog occurs on an average of 29 days per year. Clear days during the year average about 117; partly cloudy days, 191; and cloudy days, 57. The growing season, or the average period from the last frost in spring to the first frost in fall, is about 294 days.

3.3 WATER QUALITY

The Texas Commission on Environmental Quality (TCEQ), formerly the Texas Natural Resource Conservation Commission (TNRCC), and the Louisiana Department of Environmental Quality (LDEQ) have designated certain larger streams or bayous, or segments thereof, as “classified” segments for the purpose of developing water quality criteria (WQC) specific to each segment. Within the study area, there are 25 classified assessment units (subsegments of the primary stream segments), 6 in Louisiana and 19 in Texas. Table 3.2-1 lists segment-specific water quality standards (WQS) for all stream segments in the study area.

3.3.1 Water and Elutriate Chemistry

As with all industrialized areas, there is potential for chemical contamination within the Sabine-Neches Estuary. Numerous petroleum-related industries are found along the SNWW, including refineries and transshipment docks near Port Arthur and Beaumont. Petroleum products and crude oil are shipped and

Table 3.2-1
Classified Waterbody Segments and Water Quality Standards

Segment No.	Segment Name	Uses: Recreation	Uses: Aquatic Life	Uses: Domestic Water Supply	Criteria: Cl (mg/L)	Criteria: SO_4^{-2} (mg/K)	Criteria: TDS (mg/L)	Criteria: DO (mg/L)	Criteria: pH Range (SU)	Criteria: Fecal Coliform #100/ml	Criteria: Temp.
Texas											
0501	Sabine River Tidal	CR	H	N/A	N/A	N/A	N/A	4.0	6.0–8.5	200	95°F
0508	Adams Bayou Tidal	CR	H	N/A	N/A	N/A	N/A	4.0	6.0–8.5	200	95°F
0511	Cow Bayou Tidal	CR	H	N/A	N/A	N/A	N/A	4.0	6.0–8.5	200	95°F
0601	Neches River Tidal	CR	I	N/A	N/A	N/A	N/A	3.0	6.0–8.5	200	95°F
0602	Neches River Below B.A. Steinhagen Lake	CR	H	PS	50	30	150	5.0	6.0–8.5	200	91°F
0701	Taylor Bayou Above Tidal	CR	I	N/A	400	100	1,100	4.0	6.5–9.0	200	95°F
0702	Intracoastal Waterway Tidal	CR	H	N/A	N/A	N/A	N/A	4.0	6.5–9.0	200	95°F
0703	Sabine-Neches Canal Tidal	CR	H	N/A	N/A	N/A	N/A	4.0	6.5–9.0	200	95°F
0704	Hillebrandt Bayou	CR	I	N/A	250	100	600	4.0	6.5–9.0	200	95°F
2411	Sabine Pass	CR	E/O	N/A	N/A	N/A	N/A	5.0	6.5–9.0	14	95°F
2412	Sabine Lake	CR	H/O	N/A	N/A	N/A	N/A	4.0	6.5–9.0	14	95°F
Louisiana											
110301	Sabine River	A, B	C	N/A	N/A	N/A	N/A	4.0	6.0–8.5	200	95°F
110302	Black Bayou	A, B	C	N/A	N/A	N/A	N/A	4.0	6.0–8.5	200	92°F
110303	Sabine Lake	A, B	C, E	N/A	N/A	N/A	N/A	4.0	6.0–8.5	14	95°F
110304	Sabine Pass	A, B	C, E	N/A	N/A	N/A	N/A	4.0	6.0–8.5	14	95°F

A Primary contact recreation
B Secondary contact recreation
C Propagation of fish and wildlife
CR Contact recreation
E Oyster propagation
H High aquatic life use
I Intermediate aquatic life use
PS Public water supply
O Oyster waters

Cl = Chloride
SO_4^{-2} = sulfates
DO = dissolved oxygen
mg/L = milligrams per liter
ml = milliliters

piped on- and offshore in this area (Long, 1999). However, based on available data, there is no indication of current water or elutriate contaminant problems along the SNWW. Discussions on hazardous, toxic, and radioactive substances in the study area can be found in Section 3.6.

Stream segments 601, 703, and 2411 constitute the SNWW, and none of these segments are classified as nonsupporting on the Clean Water Act (CWA) Section 303(d) list of impaired waters. While several impaired stream segments (0501, 0508, 0511, 0701, and 0704) are located within the study area boundaries, they would not be affected by the direct or indirect effects of channel deepening or construction of any project features and therefore are not evaluated further.

The USACE has collected and archived a significant amount of water and sediment chemistry data. These data are grouped by channel stations (see figures 2.4-1a–g). Also included is a discussion of elutriate, which provides information on those constituents that are dissolved into the water column during dredging and placement. Since the elutriate represents the dissolved concentrations that would be expected in the water column, they are compared to the Texas Surface Water Quality Standards (TWQS), provided by the TCEQ for the protection of aquatic life, Louisiana Surface Water Quality Standards (LWQS), and EPA WQC. Since the values are from grab samples from a marine environment, the acute marine TWQS are used for comparison. Parameters analyzed are listed in Table 3.2-2.

3.3.1.1 Entrance Channel

Historical water and elutriate data for detected compounds from 1993, 1995, 1996, 1998, and 2004 are presented in PBS&J (2004a, 2004b) and Appendix B. Chromium was the only metal found above detection limits in 1993 elutriate samples in channel station, PA stations, and reference stations. However, all concentrations were well below the LWQS and TWQS for chromium. No parameters were detected in 1993 water samples. Barium was not detected in 1993, but was detected in water samples at all stations in 1995, 1996, and 1998 and in elutriate samples at most stations in 1995, 1996, and all stations in 1998. Chromium was detected at one station and copper at two stations for water in 1995. The copper value in the water sample from station S-SB-95-DA4 (26.5 micrograms per liter [µg/L]) was above the LWQS (3.63 µg/L), the TWQS (13.5 µg/L), and the Gold Book WQC (2.9 µg/L). However, S-SB-95-DA4 is a PA site located over 2 miles offshore from the end of the jetties. No copper was detected in the elutriate sample. Other metals found above detection limits in 1996 included copper in elutriate samples and zinc in both water and elutriate samples. In 1998, arsenic, cadmium, chromium, copper, and zinc concentrations were found above detection limits in water and elutriate samples, and selenium was detected in water samples only. The water copper concentration at the reference station S-SB-98-REF3+4 (3.9 µg/L) was above the LWQS and the WQC, but the copper concentration in the elutriate was below the detection limit. Barium concentrations were higher in elutriate samples than in water samples, indicating a potential release of barium into the water column during dredging and placement. Zinc concentrations for water and elutriates were higher in 1996 than in 1998, although all samples were below the LWQS and TWQS. In the 2004 sampling of the Entrance Channel, while copper, nickel, and zinc appeared to increase slightly upon elutriate preparations and selenium decreased slightly, no LWQS, TWQS, or WQC were exceeded for any channel stations. The proposed Entrance Channel Extension was also sampled in 2004 (Attachment B of Appendix B), and no WQC were exceeded for any channel station water or elutriate sample (stations were all in Federal waters and WQS were not pertinent for comparison).

Table 3.2-2
Sabine-Neches Waterway and Gulf Intracoastal Waterway
USACE Tested Parameters

Parameter	Water	Elutriate	Sediment
Ammonia		X	X
Total sulfides			X
Total volatile solids			X
Metals			
Arsenic	X	X	X
Barium	X	X	X
Cadmium	X	X	X
Chromium	X	X	X
Copper	X	X	X
Lead	X	X	X
Mercury	X	X	X
Nickel	X	X	X
Selenium	X		
Silver		X	X
Zinc	X	X	X
Polycyclic aromatic hydrocarbons (PAHs)			
Acenaphthene			X
Benzo(a)anthracene			X
Benzo(e)pyrene			X
Chrysene			X
Fluoranthene			X
Naphthalene			X
Oil and grease	X	X	X
Phenanthrene			X
Pyrene			X
Total organic carbon	X	X	X
Total PAH			X
Total polychlorinated biphenyls (PCBs)			X
Total petroleum hydrocarbons (TPH)		X	X

For organics in 1998, total petroleum hydrocarbon (TPH) was found above detection limits in two elutriate samples, and ammonia, which was not measured until 1996, was found in high concentrations for both water and elutriate samples. Total organic carbon (TOC) was not measured until 1990, but was found above detection limits for water and elutriate samples at most stations for all years sampled.

Bioassays have been conducted on samples collected from the Entrance Channel (Espey, Huston & Associates, Inc. [EH&A], 1979, 1983a, 1983b; PBS&J, 1999, 2004b; and Appendix B). Survival of organisms exposed to the liquid phase (water) and suspended particulate phase (elutriate) of sediments from the SNWW Entrance Channel was greater than 50 percent in all of these reports. Therefore, no 96-hour LC_{50} (the concentration of a substance that is lethal to 50 percent of test organisms after a continuous exposure of 96 hours) could be calculated. In such cases, the, LC_{50} is assumed to be equal to 100 percent and the dredged material would not be predicted to be acutely toxic to water column organisms since the Limiting Permissible Concentration for water column toxicity/suspended particulate phase has been met (EPA/USACE, 2003). As noted in Appendix B, this also applies to the Entrance Channel Extension.

3.3.1.2 Sabine Pass Channel

Historical water and elutriate data for detected compounds from 1987, 1990, 1992, and 1998 are presented in PBS&J (2004a). Lead and zinc were the only metals found above detection limits in 1987 at all stations in water and elutriate samples. One water sample from station S-SP-87-06 contained 98.0 μg/L of zinc that slightly exceeds the WQC (85.0 μg/L), the LWQS (90 μg/L), and the TWQS (92.7 μg/L). However, the elutriate value was low indicating no release of zinc to the water column during dredging or placement. Metals were not detected in 1990, and in 1992 the only metal found above detection limits was cadmium (in water) at station S-SP-92-06. In 1998, barium and zinc concentrations were found above detection limits for water and elutriate and were consistently higher in the elutriate samples. This contrasts to the 1987 samples, in which elutriate values were normally lower than water concentrations. Arsenic was detected at most stations in water and two stations for elutriate; cadmium and nickel were found in water only. All values, except the zinc value noted above, were below the WQC, LWQS, and TWQS.

Oil and grease were detected in 1987 in water and elutriate samples. Ammonia, which was not measured until 1996, was found above detection limits in all elutriate samples for 1998. For the organics, in 1987 fluoranthene was above detection limits at one station. TOC was detected in all water and elutriate samples during 1992, and elutriate concentrations were consistently higher than water concentrations.

3.3.1.3 Sabine-Neches Canal

Historical water and elutriate data for detected compounds from 1984, 1987, 1989, 1990, 1994, 1995, 1996, 1997, and 1998 are presented in PBS&J (2004a). Copper was the only metal found above detection limits in 1984; zinc was detected in 1987 water and elutriate samples; and metals were not detected in 1989 water and elutriate. In 1990, chromium was detected in water at one station, and zinc at two water and four elutriate stations. Barium and zinc were detected in water and elutriate samples in 1994. In 1995, barium was detected in all water and elutriate samples. One elutriate at station S-SN-95-15 contained high barium (1,096.0 μg/L). There are no WQC, LWQS, or TWQS for barium, but the Gold Book Criterion for barium in domestic water supplies (EPA, 1986) is 1,000 μg/L. Copper in elutriate samples at two stations was detected at levels greater than the WQC (2.9 μg/L) and the WQS (3.63 μg/L) but not the TWQS

(13.5 μg/L) (6.6 μg/L, S-SN-95-13 and 5.0 μg/L, S-SN-95-17). Barium and zinc were also found above detection limits in 1996 in water and elutriate samples. In 1997, barium, cadmium, copper, and nickel were found at most or all stations in water and elutriate; chromium was found in water only; selenium at one station in water; and zinc at all stations for water and one station for elutriate. In 1998, barium and zinc were found in all water and elutriate, and cadmium at one station for water. Except for the 1995 samples noted above, all values were below the WQC, LWQS, and TWQS. Recent sampling and testing within the Sabine-Neches Canal detected nickel in water sample S-SN-08-04A, and arsenic, copper, nickel, and zinc in sample S-SN-08-4A. However, all concentrations of detected metals were below the WQC, TWQS, and LWQS values. In addition, bis(2-ethylhexl)phthalate was detected at 2.31 milligrams per liter (mg/L) in the elutriate sample.

Oil and grease were detected in 1984 and 1987 in water and elutriate samples. Ammonia was above detection limits for all but one water sample in 1996 and all water and elutriate samples in 1998. For the organics, in 1997 TPH was above detection limits at one station (S-SN-97-02). TOC was detected in all or most water and elutriate samples in 1990, 1994, 1995, 1996, and 1997. Detected concentrations in the historic data for TOC were similar in value for all water and elutriate samples. Both ammonia and TOC were detected in the March 2008 water and elutriate samples. However, ammonia concentrations were below the WQC values for both water and elutriate.

3.3.1.4 Port Arthur Turning Basins

Historical water and elutriate data for detected compounds from 1984, 1987, 1989, 1992, 1994, 1996, and 1998 are presented in PBS&J (2004a). Arsenic was found above detection limits for 1984 and 1998 for elutriate samples only. Barium, for which analyses were not conducted before 1993, was detected for both water and elutriate in 1994, 1996, and 1998 (highest concentrations in 1998); cadmium was found in water samples in 1998; lead in one elutriate sample in 1992; and nickel in 1992 (elutriate only) and 1998 (water only). Copper was detected in both water and elutriates in 1984 and elutriates only in 1992 and 1998. Copper in both elutriate samples for 1984 (5.0 μg/L at stations S-PATB-84-08 and S-PATB-84-09) and one from 1992 (9.4 μg/L at station S-PATB-92-10) exceeded the WQC (2.9 μg/L) and LWQS (3.63 μg/L). One copper value from station S-PTBA-92-08 in 1992 (27.9 μg/L) exceeded the WQC, TWQS (13.5 μg/L), and LWQS. Copper was detected only once in either medium, in 1996 and 1998, below the WQC, LWQS, and TWQS. Zinc was detected in 1987 for water and elutriate, in 1992 at one station for elutriate, in 1994 and 1998 for both media. No zinc values exceeded the WQC, LWQS, or TWQS. Metals were not above detection limits for water or elutriate in 1989. Recent sampling and testing in March 2008 within the Port Arthur Turning Basin detected arsenic, nickel, and zinc in water samples, and arsenic, copper, nickel, and zinc in elutriate samples. However, all concentrations of detected metals were below the WQC, TWQS, and LWQS values.

TOC was above detection limits in water and elutriate samples for all stations in 1992, 1994, and 1996 (PBS&J, 2004a). Detected concentrations in 1996 were lower than the 1992 and 1994 samples, which were similar in value for both water and elutriates. Oil and grease were detected in 1984 and 1987 for water and elutriate samples. All oil and grease values were similar except for an increased concentration at station S-PATB-87-08 of 40.0 mg/L. No organics were detected for any year for water or elutriate samples. Ammonia was detected in all elutriate samples in 1998. Both ammonia and TOC were detected in the March 2008 water and elutriate samples. However, ammonia concentrations were below the WQC values for both water and elutriate.

3.3.1.5 Taylor Bayou Turning Basin

Historical water and elutriate data for detected compounds from 1989, 1994, 1996, and 1998 are presented in PBS&J (2004a). Of the metals, arsenic was found in both water and elutriate at two stations in 1998. Barium was above detection limits in both media in 1994, 1996, and 1998 (highest concentrations in 1998). Cadmium was found in all water samples and nickel in two water stations in 1998. Zinc was detected in 1994 and 1996 in both water and elutriates at all stations and in 1998 for all elutriate samples only (1998 concentrations were the highest). No WQC, LWQS, or TWQS were exceeded. Metals were not above detection limits for water or elutriate in 1989.

TOC was above detection limits for water and elutriates for all stations in 1994 and 1996, and in 1998 for water only (PBS&J, 2004a). No other organics were detected for any year in water and elutriate samples. Ammonia was detected in all elutriate samples in 1998, as has been seen with all reaches sampled of the SNWW.

3.3.1.6 Port Arthur Canal

Historical water and elutriate data for detected compounds from 1987, 1989, 1990, 1992, 1994, 1996, and 1998 are presented in PBS&J (2004a). For the metals, lead and zinc were found above detection limits in both water and elutriate samples in 1987. Zinc was the only metal detected in 1990, and the elutriate value at station S-PA-90-05 (550.0 μg/L) was well above the WQS (85.0 μg/L), LWQS (90.0 μg/L), and TWQS (92.7 μg/L). Since zinc was not detected in water at that station or in the water or elutriate samples 500 feet up and down stream, and the sediment zinc concentration was not high relative to nearby stations, this value appears to be an error. In 1992, lead was the only metal found above detection limits in the elutriate sample. Barium and zinc were detected in both water and elutriates in 1994, and in 1996 barium was found in both media and zinc in elutriate only. For 1998, arsenic was detected in water samples only at 4 of 14 stations; barium in all water and all but one elutriate sample; cadmium in most water and one elutriate sample; copper in most water samples; and nickel at 4 stations. Zinc was also detected in all water and elutriates, at the highest concentrations when compared to historic values. None of the WQC, LWQS, or TWQS was exceeded. Recent sampling and testing in March 2008 within the Port Arthur Canal detected nickel in water samples, and arsenic, copper, nickel, and zinc in elutriate samples. However, the concentrations of metals in both the water and elutriate samples were below the WQC, TWQS, and LWQS values.

Oil and grease were only detected in water and elutriate samples in 1987. TOC was above detection limits in water and elutriate samples for all stations in 1992, 1994, and 1996. No other organics were detected in any year for water and elutriate samples. Ammonia was detected in one elutriate sample (S-PA-98-01) in

1998. Both ammonia and TOC were detected in the March 2008 water and elutriate samples. However, ammonia concentrations were below the WQC values for both water and elutriate.

3.3.1.7 Neches River Channel

Historical water and elutriate data for detected compounds from 1988, 1990, 1994, 1995, and 1997 are presented in PBS&J (2004a). The 1995 stations were sampled in March and September of that year. Of the metals, zinc was detected in water samples from all or most stations in 1990, 1994, and 1997, and elutriate samples in 1994 and 1995 at most stations. However, all concentrations were well below the WQC, LWQS, and TWQS for zinc. Barium was detected in 1994, 1995, and 1997 at all water and elutriate stations. Cadmium was detected in water and elutriate samples from 1997; nickel was detected in three elutriate samples in 1995 and water in 1997; and lead in one elutriate sample (S-NR-95-21, September) in 1995. In 1995 (September), chromium was detected in two water samples and most elutriate samples. Copper was found in all 1995 (September) elutriate samples; all were well above the TWQS (13.5 µg/L), WQC (2.9 µg/L), and LWQS (3.63 µg/L) ranging from 23.8 µg/L to 55.6 µg/L. However, copper concentrations were below detection limits during the March sampling. No metals were detected in water and elutriate in 1988. Except for the copper concentrations noted above, all values were below WQC, LWQS, and TWQS. Recent water and elutriate sampling and testing in the Neches River Channel occurred in April 2009. Results of the tests show all metal concentrations below WQC, LWQS, and TWQS values.

TOC was above detection limits for water and elutriate samples for all stations in 1990, 1994, 1995, and 1997 (PBS&J, 2004a). No other organics were detected in any year for water and elutriate samples. Both ammonia and TOC were above detection limits for water and elutriate in the April 2009 samples. Chrysene (1.16 µg/L), benzo(a)anthracene (0.45 µg/L), benzo(k)fluranthene (0.53 µg/L), and benzo(a)pyrene (0.51 µg/L) were also found in an elutriate duplicate sample from April 2009. There are no WQSs for these PAHs. However, ammonia concentrations were below the WQC for both water and elutriate.

3.3.1.8 Sabine River Channel

Historical water and elutriate data for detected compounds from 1990 and 1995 are presented in PBS&J (2004a). Of the metals, zinc was detected in two of seven water samples and three of seven elutriate samples, but all concentrations were below TWQS, LWQS, and WQC. No other metals were detected in 1990 water and elutriate samples. In 1995, barium was above detection limits in all water and elutriate samples. Copper was detected in all elutriate samples, which were all above the WQC (2.9 µg/L) and LWQS (3.63 µg/L), ranging from 5.0 µg/L to 7.5 µg/L. Lead was also found in elutriates at one station (S-SR-95-04) but at concentrations well below the LWQS, TWQS, and WQC.

TOC was not detected in 1990, but was found above detection limits in all water and elutriate samples in 1995. No other organics were detected in 1990 or 1995.

3.3.1.9 GIWW – Port Arthur to High Island

Historical water and elutriate data for detected compounds for 1983 and 1993 are presented in PBS&J (2004a). Arsenic was the only metal detected in 1983, and it was found in all water and elutriate samples; however, it was not detected in 1993. In 1993, barium and zinc were found above detection limits in all water and elutriate samples, and in most cases elutriate concentrations were higher than water concentrations. All concentrations were less than the LWQS, TWQS, and WQC.

Oil and grease were detected in water and elutriate samples in 1983. TOC was above detection limits for water and elutriates for all stations in 1993 (PBS&J, 2004a). Ammonia was detected in most elutriate samples from 1983, but in none from the GIWW from 1993.

3.4 SEDIMENT QUALITY

Data collected by the USACE since 1983 were analyzed to determine the sediment quality of the SNWW. These samples of maintenance material are collected periodically before a maintenance-dredging event, following noncontaminating procedures approved by the USACE and EPA. Reference station material, for comparison with the maintenance material, is collected from areas in the vicinity of and similar to the maintenance material stations, but which have not been impacted by dredging and dredged material placement. For example, the reference station for the Upper Neches River Channel bioassays and chemistry was located in an oxbow off the channel and surrounded by nonindustrial land; the Lower Neches River Channel reference station was located in the Bessie Heights area where the channel material would be used beneficially; the Sabine-Neches Canal reference station was located in east Sabine Lake, near the Sabine NWR; and offshore reference stations were located in designated reference areas, up-current of the channel (PBS&J, 2004a; Appendix B).

There are no sediment quality criteria with which to compare concentrations in the sediment; however, there are several different guidelines that are used to look for a cause for concern in sediment samples. One guideline is the Effects Range Low, or ERL. ERL were developed by a technique that demonstrates no cause and effect from the chemicals in the data set. When ERL derived from sets of data from different areas are compared, the results are inconsistent (USACE, 1998b). Since the ERL are not based on cause and effect data, they are used only to determine a possible “cause of concern.” The ERL presented here are those given in the NOAA 1999 Screening Quick Reference Tables (Buchman, 1999). Where applicable, reference stations were examined, and in most cases, concentrations were within a factor of five relative to these stations, which is normal, as an examination of years of data collected from maintenance material along the waterway of Texas will show (USACE database). Also, while “higher than” is used in the following discussion, this only means that one concentration is numerically higher than another. However, there was no replication for these samples, and statistical significance, if any, could not be determined.

The need for determining a “cause for concern” is based on the guidance documents developed by the EPA and USACE. Specifically, the *Inland Testing Manual* (ITM) (EPA/USACE, 1998) and the Regional Implementation Agreement (RIA) (EPA/USACE, 2003), which are guidance manuals in EPA Region 6 for inland (including bays) and ocean placement of dredged material, respectively, use a structured hierarchical procedure for determining data needs relative to decision-making. This involves a series of tiers or levels of intensity of investigation—the tiered approach. Typically, tiered testing involves decreased uncertainty and increased available information with increasing tiers. This approach is intended to ensure the maintenance and protection of environmental quality, as well as the optimal use of resources. Specifically, least effort is required in situations where clear determinations can be made whether unacceptable adverse impacts are likely or not likely to occur based on available information. Most effort is required where clear determinations cannot be made with available information. The tiered approach to testing in this ITM and RIA must be initiated at Tier I. The tiered approach is designed to aid in generating physical, chemical, toxicity, and bioaccumulation information, but not provide more information than is necessary to make factual determinations. Tiered testing results in environmental protection by producing a more efficient compilation of necessary evaluations at reduced costs, especially to low-risk operations. Disposal operations that obviously have low environmental impact generally should not require intensive investigation to make factual determinations.

It is necessary to proceed through the tiers only until information sufficient to make factual determinations has been obtained. For example, if the available information is sufficient to make factual determinations, no further testing is required. The initial tier (Tier I) uses readily available, existing information (including all previous testing). More-extensive evaluation (tiers II, III, and IV) may be needed for materials that have a clear potential for impact or for which Tier I information is inadequate to determine the lack of potential for impacts. Tier II is concerned solely with sediment and water chemistry, including comparison of elutriates to WQSs and WQC. Tier III is concerned with well-defined, nationally accepted toxicity and bioaccumulation testing procedures. Tier IV allows for case-specific laboratory and field testing, and is intended for use in unusual circumstances. The approach is to enter Tier I and proceed as far as necessary to make factual determinations, i.e., there must be enough information available to make determinations on water column impact, benthic toxicity, and benthic bioaccumulation. The tests in the ITM and RIA reflect the present state-of-the-art procedures for dredged material evaluation.

The need to determine a "cause for concern" is driven by the tiered approach. If a "cause for concern" arises, sufficient information must be gathered to determine whether the dredged material is acceptable for in-bay or ocean placement. Therefore, the ERL is used as a tool to determine whether there might be a concern with the dredged material, as WQS were used for elutriates. The WQS are standards that must be met whereas the ERLs have no statutory authority.

3.4.1 Sabine-Neches Waterway

3.4.1.1 Entrance Channel

Historical sediment data for detected compounds from 1993, 1995, 1996, 1998, and 2004 are presented in PBS&J (2004a, 2004b) and Appendix B. Of the metals, chromium, copper, lead, and nickel were detected at all stations for all years. At PA station S-SB-93-DA3, in 1993, copper was detected at a concentration of 70.0 milligrams per kilogram (mg/kg), much greater than the concentrations found at the reference stations, channel stations, and other PA stations and the DA3 station in 1995. Therefore, it appears to be an aberrant value. Cadmium was detected at all stations in 1993 and 1998; barium and zinc in 1995, 1996, and 1998 at all stations; and arsenic was detected in 1998 at all stations. The zinc concentrations in 1995 were slightly higher than the reference stations. In 2004, the most-inshore station (adjacent to ODMDS 4) tended to have the highest sediment concentration, and the ERL for arsenic was exceeded at this station. However, the elutriate concentration was well below WQS and WQC, and bioassays indicated no toxicity. There were no trends in the data, and no ERL were exceeded by samples from the Entrance Channel Extension in the 2004 samples. The sediments at the channel stations were mostly silt and clay, whereas sediments from the reference and PA stations generally contained a higher sand content. Since trace metal concentrations tend to be positively correlated to silt/clay concentrations, slightly higher metals concentration would be expected in the channel sediments.

Of the organics, TOC was detected only in 1998 but at high concentrations when compared to the reference station. The TOC values were so much higher that there was likely a change in methodology in 1998 because an error in units would not account for the difference. Total volatile solids (TVS) and ammonia (both not measured until 1993) were detected in 1996 and 1998. The reference stations were below detection limits for TVS and in 1998 for ammonia only. However, concentrations of TVS were at least five times the detection limits and ammonia concentrations were also above detection limits in 1996 (S-J-96-DA4) and in 1998 (S-J-98-02, S-J-98-03, and S-SB-98-02). Total sulfides, which was not measured until 1993, were detected in 1998 at most stations at concentrations higher than the reference stations (S-SB-98-REF3&4) that had concentrations below detection limits.

Solid phase bioassays were conducted on Entrance Channel sediments in 1999 (PBS&J, 1999) and in 2004 (PBS&J, 2004b) and on Entrance Channel Extension sediments in 2004 (Appendix B). In all cases, there were no tests in which survival in the Reference Control was greater than survival in the treatments and the difference exceeded 10 percent (20 percent for the amphipods), requiring statistical analysis. Therefore, the survival data from the solid phase bioassay indicate no potential for environmentally unacceptable toxic impacts to benthic organisms from the placement of dredged material from the Entrance Channel or Entrance Channel Extension. Bioaccumulation data in 2004 likewise indicated no expectation of adverse impacts to benthic organisms from the placement of Entrance Channel or Entrance Channel Extension dredged material.

3.4.1.2 Sabine Pass Channel

Historical sediment data for detected compounds from 1987, 1990, 1992, and 1998 are presented in PBS&J (2004a). Arsenic was above detection limits at one station in 1987 and at all stations in 1998. Chromium, copper, nickel, and zinc were detected at all stations in 1987, 1990, 1992, and 1998. Lead was found in 1987, 1992, and 1998 at all stations. Oil and grease were detected only in 1987 but at all stations; TOC was detected at all stations in 1998 (see subsection 3.3.1.2); total PCBs were detected at two stations in 1987; and TVS was detected in 1998 at all stations. Ammonia was detected at all stations in 1998 with the concentration at station S-SP-98-04 (21.4 mg/kg) much higher than at the other stations.

3.4.1.3 Sabine-Neches Canal

Historical sediment data for detected compounds from 1984, 1987, 1989, 1990, 1994, 1995, 1996, 1997, and 1998 are presented in PBS&J (2004a). Arsenic was detected in 1984, 1987, and 1997 at all stations; barium at all stations from 1994 to 1998; chromium in 1987 through 1997 at all stations; copper at every station for all years except 1998; lead in 1987 and 1994 to 1998 at all stations; mercury in 1997 at most stations; nickel in 1989, 1990, 1997, and 1998 at all stations; and zinc in all years at every station. These values were roughly in the same range in all years. However, one station in 1990 (S-SN-90-09) had a copper concentration of 40.0 mg/kg, much higher than the other stations for which values ranged from 3.3 mg/kg to 8.1 mg/kg. This anomalous value of copper does not indicate a cause for concern, since values were lower in subsequent years. Recent sediment samples collected in March 2008 within the Sabine-Neches Canal showed an arsenic concentration slightly greater (9.7 mg/kg) than the ERL value (8.2 mg/kg). All other detected metal concentrations were below the ERL values.

For the organics, TOC was detected in 1994, 1995, 1997, and 1998 with the concentrations in 1998 higher than in previous years (see subsection 3.3.1.3). Oil and grease were detected in 1984 (highest concentration) and 1987; total PAHs only in 1987; and the PAHs, fluoranthene and benzo(a)pyrene in 1987 and 1989 (highest concentration). In 1997, the PAHs, phenanthrene, pyrene, benzo(a)anthracene, and chrysene, plus TPH were detected at most stations. TVS and ammonia were detected at most stations in 1996 through 1998. Total sulfides were only detected in 1996 at three out of seven stations. All values were roughly in the same ranges in all years. Both ammonia and TOC were detected in the March 2008 sediment sample (S-SN-08-04A).

3.4.1.4 Port Arthur Turning Basins

Historical sediment data for detected compounds from 1984, 1987, 1989, 1992, 1994, 1996, and 1998 are presented in PBS&J (2004a). Arsenic was above detection limits in 1984, 1987, and 1998 at all stations, except for one in 1984. Barium was also found in 1994, 1996, and 1998 at all stations. Chromium, copper, lead, nickel, and zinc were detected in 1987, 1989, 1992, 1997, 1996, and 1998 at all stations, with the exception of lead, which was not detected in 1989. These values were roughly in the same ranges in all years. Recent sediment samples collected and tested in March 2008 detected arsenic concentrations in all samples slightly greater than the ERL value of 8.2 mg/kg. The arsenic concentrations in the samples ranged from 8.7 to 11.9 mg/kg. In addition, one sediment sample (S-PATB-08-08) had a copper concentration (49.6 mg/kg) that slightly exceeded the ERL value of 34.0 mg/kg. Chrysene (at 65.3 micrograms per kilogram [µg/kg] vs. ERL = 384 µg/kg), butylbenzylphthalate (66.9 µg/kg vs. no ERL), and pyrene (at 68.5 µg/kg vs. ERL = 665 µg/kg) were found in sample S-PATB-08-08 in March 2008.

TOC was found in 1994 and 1998 at all stations, the 1998 concentrations being much higher than in 1994 (see subsection 3.3.1.4). Total PAH, fluoranthene, and benzo(a)pyrene were detected in 1987 at all stations. Fluoranthene was found at a higher concentration (24.1 mg/kg) at station S-PATB-87-09 than at the other stations. Benzo(a)pyrene was also found at two of three stations in 1989; benzo(e)pyrene in

1996, at one of three stations; and ammonia in 1998, at all stations. Also, oil and grease, in 1984 and 1987, and TVS in 1998, were detected at all stations. Both ammonia and TOC were detected for all sample stations in March 2008.

3.4.1.5 Taylor Bayou Turning Basin

Historical sediment data for detected compounds from 1989, 1994, 1996, and 1998 are presented in PBS&J (2004a). For the metals, chromium, copper, nickel, and zinc were found in all years at all stations. Zinc concentrations were higher in 1994 and 1998, when compared to the 1989 data; however, there are not enough data to indicate a trend. The concentration of copper at station S-PATB-89-12 was 70.0 mg/kg, much higher compared to the data from other years, including later years and, interestingly, at the same anomalous concentration found at S-SB-93-DA3 (see subsection 3.3.1.1). Therefore, there is no trend of increasing copper concentrations with time. Barium was detected in 1994, 1996, and 1998 at all stations, and arsenic in 1998 at all stations. The barium values were roughly the same ranges in all years.

TOC was detected in all 1994 and 1998 samples, the greatest concentrations occurring in 1998 (see subsection 3.3.1.5). Naphthalene was found at one station in 1996; benzo(a)pyrene at one station each in 1989 (14.1 mg/kg) and 1996 (41.5 mg/kg); and benzo(e)pyrene in 1996. Ammonia and TVS were detected in 1998 at all stations.

3.4.1.6 Port Arthur Canal

Historical sediment data for detected compounds from 1987, 1989, 1990, 1992, 1994, 1996, and 1998 are presented in PBS&J (2004a). Nickel and zinc were found in all years at all stations; chromium and copper in all years at most stations; and lead was found in all years (except 1990) at all stations. Arsenic was detected in 1987 at one station and in 1998 at all stations; and barium was detected in 1994, 1996, and 1998 at all stations. All values were in the same range in all years, with the exception of barium in 1994 and 1996, which had more-elevated concentrations than in 1998 values. Recent sediment samples collected and tested in March 2008 detected arsenic concentrations slightly in excess of ERL values for stations S-PA-08-02 (8.95 mg/kg) and S-PA-08-07 (dup) (9.82 mg/kg). All other metals detected had concentrations below ERL values.

Oil and grease were detected in 1987 at all stations. TOC was found in 1994, 1996, and 1998 at all stations, with the 1998 values being the highest (see subsection 3.3.1.6). In 1987, total PAH and fluoranthene were detected at one station, and benzo(e)pyrene was detected in 1996. Ammonia and TVS were detected at station S-PA-98-01 in 1998. Both ammonia and TOC were detected in all samples tested in March 2008.

3.4.1.7 Neches River Channel

Historical sediment data for detected compounds from 1988, 1990, 1994, 1995, and 1997 are presented in PBS&J (2004a). Chromium, copper, nickel, and zinc were found at most or all stations for each year.

Lead was also detected in all years, except 1990, and at most stations, consistent with what was found at the other reaches for this same year. Arsenic was detected in 1988 and 1997 at most stations; barium was detected in 1994, 1995, and 1997 at all stations; and cadmium was detected at most stations in 1988 and 1997. Two stations (S-NR-88-21 and S-NR-88-18) exhibited greater copper concentrations (30.0 mg/kg) when compared to the other stations. Barium concentrations were higher in 1994 than in subsequent years. All other concentrations fell within similar ranges for all years.

Recent sediment sampling and testing occurred in the Neches River on April 1, 2009. Results of the tests showed arsenic at four sample stations (S-NR-09-05, -06, -10, and -11) slightly exceeding ERLs. The exceeded values ranged from 8.37 to 9.41 mg/kg, as compared to the arsenic ERL of 8.2 mg/kg. All other detected concentrations for the remaining metals were below ERL values. Both ammonia and TOC were found above the detection limits in April 2009.

TOC was above detection limits for 1994, 1995, and 1997 at most stations, with concentrations in 1994 the highest (95.0 to 622.0 mg/kg). Naphthalene, fluoranthene, and benzo(a)pyrene were detected in 1994 and 1995 at a few stations. The concentrations of benzo(a)pyrene in 1994 ranged from 36.0 to 533.0 mg/kg, at higher concentrations than in other years. The greatest concentration of fluoranthene occurred in 1995 at station S-NR-95-19 at 266.8 mg/kg. Total PAH, acenapthene, and benzo(e)pyrene were above detection limits in 1995. Concentrations of acenapthene at some stations are high (ranging from 81.4 to 321.9 mg/kg) relative to other stations. Also, TPH, TVS, and ammonia were found above detection limits at in 1997.

3.4.1.8 Sabine River Channel

Historical sediment data for detected compounds from 1990 and 1995 are presented in PBS&J (2004a). In 1990, chromium, copper, nickel, and zinc were above detection limits at all stations. One copper concentration at station S-SR-90-05 was higher (40.0 mg/kg) than at the other stations, but all other concentrations were within the same ranges. In 1995, barium, chromium, copper, lead, nickel, and zinc were above detection limits at all stations. Mercury was found at stations S-SR-95-02 (0.26 mg/kg) and S-SR-95-06 (0.36 mg/kg). Benzo(a)pyrene was found in 1990 at one station at a concentration of 10.0 mg/kg.

3.4.1.9 GIWW – Port Arthur to High Island

Historical sediment data for detected compounds for 1983 and 1993 in the Port Arthur to High Island segment of the GIWW are presented in PBS&J (2004a). Chromium, copper, lead, nickel, and zinc were above detection limits in both years at most stations. Arsenic was also detected in 1983 at all stations; and barium and cadmium were detected at all stations in 1993. All values were roughly the same for both years. TOC was found in 1993 at all stations, with higher concentrations at stations GIP-PAHI-93-17 (528.0 mg/kg) and GIP-PAHI-93-33 (204.0 mg/kg). Ammonia was also above detection limits in 1983 at all stations.

3.4.2 Summary

In summary, an examination of the sediment data presented in PBS&J (2004a), and sediment data recently collected in March 2008 and April 2009, indicates no cause for concern, with the possible exception of elevated PAHs in one reach of the Neches River. There are nine sites listed in Table 3.3-1 that are considered to be priority Hazardous, Toxic, and Radioactive Waste (HTRW) sites, and there is a reach of the Neches River (stations 750 + 000 to 950 + 000, see Figure 2.4-1g) that has higher sediment PAH concentrations than other reaches of the SNWW, but the location of the sites in Table 3.3-1 do not correlate to the higher-PAH reach of the Neches River. Additionally, none of those PAHs are found in the elutriate samples from the higher-PAH reach of the Neches River (Section 3.3), so there is no indication that those PAHs would be released during dredging and/or placement. Taking all of this information into account, there appear to be no reaches of the SNWW that exhibit a cause for concern.

Table 3.3-1
Summary of Priority HTRW Sites within Sabine-Neches Waterway

Site Name	Site ID	Constituents of Concern	Media Impacted	Status
Bailey Waste Disposal Site	512	Arsenic compounds, benzene, phenols, pyridenes, naphthalenes, and chlorinated hydrocarbons	Surface water, groundwater, soils	Cleanup complete in 1998; Operation and Maintenance underway since 1999
State Marine	203	PAHs, metals	Surface water	Evaluation and cleanup are underway, but the nature and extent of contamination and the risks posed to human health and the environment are unknown
Palmer Barge Lines	548	Aluminum, barium, chromium, cobalt, iron, lead, magnesium, nickel, zinc, pesticides, volatile organic compounds (VOCs), PAHs, pentachlorophenol (PCP), and benzene	Surface water	Evaluation and cleanup underway since 2000; the EPA is considering various remedial alternatives
Star Lake Canal	471	Chromium, copper, PAHs, and PCBs	Surface water, sediment	Evaluation and cleanup underway since 2001, but the nature and extent of contamination and the risks posed to human health and the environment are unknown
International Creosoting	30	Arsenic, chromium, lead, creosote compounds, semivolatile organic compounds (SVOC), and VOCs	Groundwater, sediment, soil, surface water	Clean up underway
Maintech International	410	PAHs	Groundwater, soils	Cleanup completed in 2000; undergoing Operation and Maintenance
Excell	28	TPH, benzene, toluene, ethylbenzene, and xylene	Groundwater	Investigation underway
Port of Beaumont, Beaumont Elevator	113	VOCs, herbicides, and pesticides	Groundwater, soils	Investigation underway
Woodcrest Site	584	VOCs	Soil	Investigation underway

Source: Banks Information Solutions (2002).

3.5 HYDROLOGY

The study area is located within the Neches-Trinity Coastal Basin, the lower Neches River Basin, the lower Sabine River Basin, and the Calcasieu/Sabine River Basin. The Sabine River Basin is long and narrow with a length of approximately 300 miles. The basin has a watershed area of about 9,756 square miles, including 7,396 square miles in Texas. The Sabine River flows southeasterly from its source in Hunt County, Texas, for about 165 miles to the Texas-Louisiana border in the vicinity of Logansport, Louisiana. From there, the river flows in a southerly direction to Sabine Lake and the Gulf. Land surface elevations in the Sabine River watershed vary from a few feet above sea level near the coast to approximately 700 feet above mean sea level at the headwaters. The Sabine River Tidal section is 24 miles long starting from the confluence with Sabine Lake in Orange County to West Bluff in Orange County. Three large tributaries drain into the Sabine River Tidal section within the study area. These tributaries are Little Cypress, Cow, and Adams bayous.

The Neches River originates in southwest Van Zandt County and flows southeasterly through the Piney Woods of east Texas to the confluence with the Angelina River. The upper Neches River has a watershed of about 7,451 square miles and is approximately 150 miles in length. The Neches River Tidal section is 27 miles long starting from the confluence with Sabine Lake in Orange County to a point 7 miles upstream of IH 10 in Orange County. The hydrology of the Neches River Tidal segment is influenced by tidal and freshwater exchange with Sabine Lake and the Sabine-Neches Canal at the lower end of the stream segment, and by freshwater inflows from Pine Island Bayou and the Neches River at the upper end of the stream segment.

Sabine Lake is formed by the confluence of the Neches and Sabine rivers. The lake is 68.7 square miles in size and is fairly shallow, averaging about 4 to 6 feet in depth. The lake is located at the east side of the SNWW from Port Arthur and Pleasure Island. Sabine Lake has a drainage area of approximately 50,000 square miles in Texas and Louisiana that results in freshwater inflow of about 13 million acre-feet per year (McFarlane, 1996). Between Sabine Lake and the Gulf lies Sabine Pass. It is 2.1 square miles in size and is located from the end of the jetties at the Gulf to SH 82.

In addition to the Neches and Sabine rivers, Sabine Lake and the SNWW are fed by a number of smaller watercourses from both the Texas and Louisiana sides of the lake. From Louisiana, several smaller watercourses including Greens Bayou, Johnson's Bayou, Willow Bayou, Three Bayou, Lighthouse Bayou, Starks Canal, Hog Island Gully, West Cove Canal, and Black Bayou drain the Sabine NWR area and provide water exchange between the Sabine Lake and Calcasieu Lake systems. From Texas, the smaller waterbodies contributing to Sabine Lake and the SNWW include Old River Bayou draining to Old River Cove at the north end of Sabine Lake; Bessie Heights Canal draining the Bessie Heights Marsh area; Taylor Bayou draining the Big Hill Reservoir area and the J.D. Murphree WMA; the Keith Lake Channel draining surrounding lakes and marshland to the SNWW; Salt Bayou draining the McFaddin NWR and Sea Rim State Park; and Star Lake draining the southern areas of the McFaddin NWR and surrounding area. Of these smaller waterbodies, the following areas are of particular concern to this study:

- Bessie Heights Canal, located on the Neches River approximately 10 miles upstream of Rainbow Bridge, drains the Bessie Heights Marsh area and the Bessie Heights Oil and Gas Field. There are numerous small canals associated with the development of the oil field feeding into Bessie Heights Canal. These smaller canals have caused increased saltwater intrusion into the marshlands of the Bessie Heights area.
- Salt Bayou, located in southern Jefferson County, feeds Salt Lake and drains the McFaddin NWR to the eastern portion of the GIWW. A water control structure, known as the Salt Bayou Structure, located at the outlet of Salt Bayou into the GIWW prevents saltwater intrusion via the GIWW into the surrounding marshlands that were affected by the deepening of the GIWW and SNWW. The Salt Bayou Structure works in conjunction with the Salt Lake Structure at Perkins Levee to control salinity levels in the McFaddin NWR, Sea Rim State Park, and the J.D. Murphree WMA. The Salt Bayou system is affected by the SNWW through the opening at the Keith Lake Fish Pass.
- Black Bayou estuary and eastern shoreline of Sabine Lake located in Cameron and Calcasieu parishes. This area has suffered significant erosion and loss of marsh area. According to the Louisiana Coast 2050 report (LCWCR/WCRA, 1998), the Black Bayou mapping unit had lost 4,900 acres of marshland between 1978 and 1990 because of altered hydrology and wave/wake erosion.
- Willow Bayou estuary, located in Cameron Parish primarily in the Sabine NWR. This area has suffered significant Sabine Lake shoreline erosion and loss of interior marsh. From 1974 to 1990, 1,140 acres were lost (LCWCR/WCRA, 1999).

Eleven water quality segments, as designated by TCEQ, are included in the Sabine River, Neches River, Sabine Lake, and Sabine Pass. While these segments do not necessarily pertain to hydrology, they are useful for delineating waterbodies for discussion purposes. These include:

Segment	Identification
0501	Sabine River Tidal
0501B	Little Cypress Bayou
0502	Sabine River Above Tidal
0508	Adams Bayou Tidal
0508A	Adams Bayou Above Tidal
0511	Cow Bayou Tidal
0511A	Cow Bayou Above Tidal
0601	Neches River Tidal
0601A	Star Lake Canal
2411	Sabine Pass
2412	Sabine Lake

Upstream of Sabine Pass (excluding the Sabine and Neches river segments) is the Neches-Trinity Coastal Basin and the Sabine River Basin, which include the following major waterbodies or segments as designated by TCEQ. However, some of these waterbodies do not drain into the SNWW.

Segment	Identification
0701	Taylor Bayou Above Tidal
0701D	Shallow Prong Lake
0702	Intracoastal Waterway Tidal
0702A	Alligator Bayou
0703	Sabine-Neches Canal Tidal
0704	Hillebrandt Bayou
0704A	Willow Marsh Bayou
0704B	Kidd Gully
110301	Sabine River confluence with Old River below Sabine Island WMA to Sabine Lake
110302	Black Bayou from boundary between segments 1103 and 1106 to Sabine Lake
110303	Sabine River
110303	Sabine Pass
110602	Black Bayou – Intracoastal Waterway to boundary between segments 1103 and 1106
110701	Sabine River Basin Coastal Bays and Gulf Waters to the State 3-mile limit

The coastal watersheds along SNWW are generally flat and consist of coastal forested wetlands and marshes, and prairies. The extensive marshlands occur in areas less than 5 feet above mean sea level and extend inland 4 to 15 miles along the entire Gulf shoreline. Marshes and associated swamps extend up the reaches of the Sabine and Neches rivers.

Although the geomorphology of the system indicates that the Sabine Lake estuary was historically a freshwater environment, a survey of the Sabine River by the USACE in 1879 suggests Sabine Lake may have had at least periods of natural saltwater intrusion. Description of plant communities near the mouth of the Sabine River at Sabine Lake indicated the absence of riparian vegetation typical of freshwater rivers in this region and the presence of salt-tolerant plants (USACE, 1980). It is likely that saltwater intrusion may have occurred with tidal surges from Gulf storms resulting in an estuarine environment.

3.5.1 Freshwater Flows

The SNWW contains perennial freshwater flow from both the Neches and Sabine rivers and their tributaries as well as tidal flow from the Gulf. The USGS maintains a set of gauge stations in the study area (http://waterdata.usgs.gov/tx/nwis/rt), including:

USGS 08041000	Neches River at Evadale, Texas
USGS 08041500	Village Creek near Kountze, Texas
USGS 08041700	Pine Island Bayou near Sour Lake, Texas
USGS 08030500	Sabine River near Ruliff, Texas
USGS 08042522	Taylor-Alligator Bayou Pump Station near Port Arthur, Texas

Of these, the USGS gauge near Evadale on the Neches River (08041000), with peak flow records from 1884 to present, and the gauge near Ruliff on the Sabine River (08030500), with peak flow records from 1924 to present, contain the flow data that can best describe the freshwater inflow into the study area. The Evadale gauge has a drainage area of 7,951 square miles, and the Ruliff gauge has a drainage area of

9,329 square miles. Both gauges are upstream of Sabine Lake. Peak flow records for the Evadale and Ruliff gauges range from 5,890 cubic feet per second (cfs) on October 30, 1970, to 125,000 cfs in 1884 and 11,100 cfs on June 11, 1981, to 121,000 cfs on May 22, 1953, respectively. Typical dry weather flows on both the Sabine and Neches rivers each average about 1,200 cfs. Information developed by the Waterway Experiment Station of the USACE (Vicksburg District) indicated that 10 percentile flows range from 57,100 to 418,500 acre-feet/month; mean flows range from 342,400 to 1,540,000 acre-feet/month; and 90 percentile flows range from 612,500 to 3,302,000 acre-feet/month.

3.5.2 Water Exchange Patterns between Calcasieu and Sabine Lakes

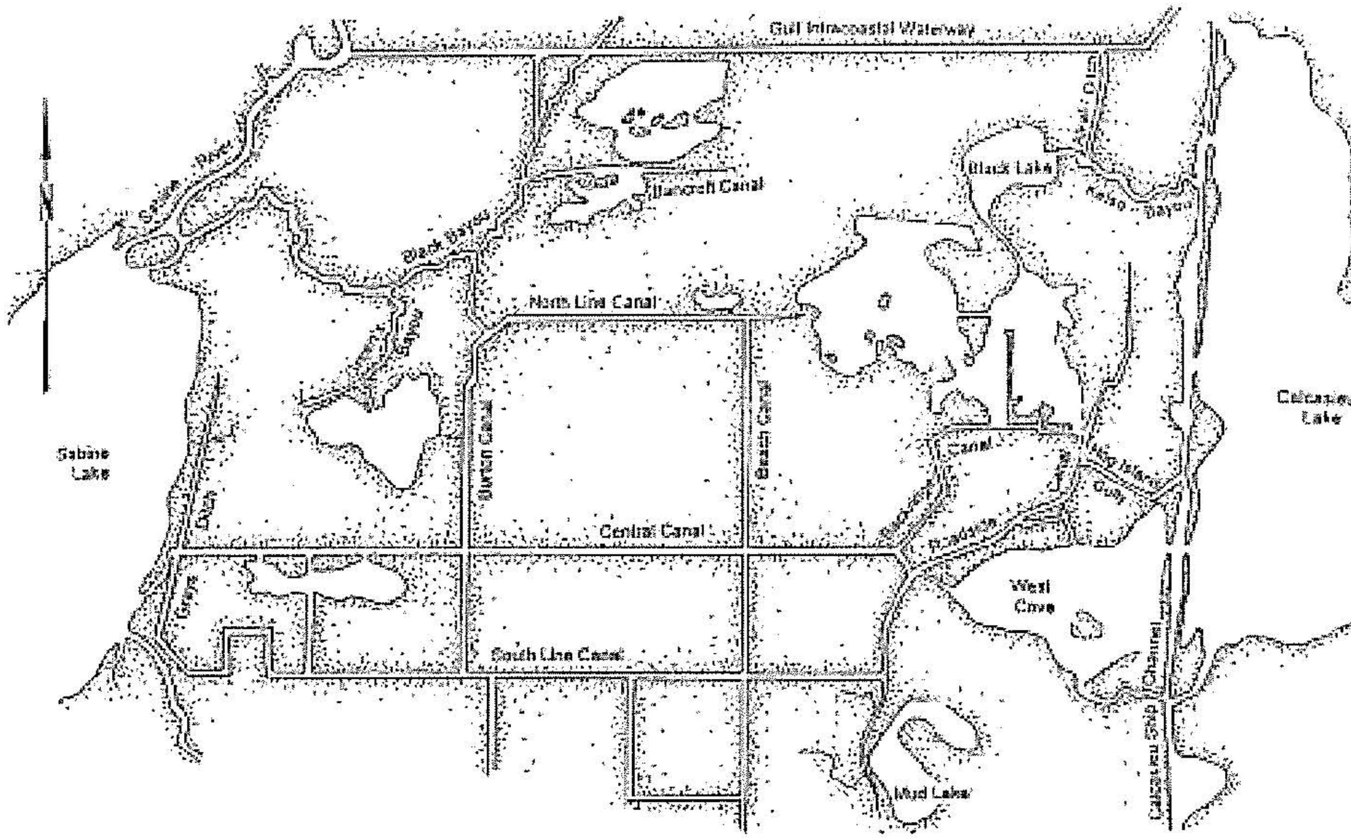
Water exchange between Calcasieu and Sabine lakes occurs through the marsh of the Sabine NWR, located between Calcasieu and Sabine lakes and midway between the GIWW to the north and the Gulf to the south. The GIWW, North Line Canal, Central Canal, and South Line Canal provide hydrologic connections between the two lakes, as shown on Figure 3.5-1. With the exception of a few freshwater marsh impoundments, the area south of the GIWW is tidally influenced, and water level and flow direction can vary daily with tide, wind, stormwater runoff, river stage, barometric pressure, and control-structure operations. Studies of the area have shown that wind is the primary force affecting the flow patterns between the two lakes, resulting in flow patterns that overpower the effects of lunar tides (Paille, 1996).

During prolonged periods of strong southeast and south winds (typically occurring prior to frontal passage), a large volume of Gulf water is forced into Calcasieu and Sabine lakes, raising water levels in the area. The rise in water levels in the lakes causes strong incoming flows to occur in the surrounding marshes. The large area of marsh and shallow open water extending northward from Backridge Canal to Hackberry can also experience a push of water northward. This northward push of water causes water levels in the southern end of the open-water area to lower, facilitating flow into the area from Calcasieu Lake via Hog Island Gully and Kayo Bayou. In addition, the Roadside Canal flows strongly toward the southern end of the open water, importing water from Calcasieu Lake via the Headquarters Canal and West Cove Canal water control structures. During these wind conditions, Backridge Canal flows northward toward the southern end of the open area. At the northern end of the open-water area, these high-tide conditions result in discharge of water through Rycade Canal toward Black Lake. The discharge through Rycade Canal is often very strong as a result of substantial head differential that can be created by the wind-induced lowering of water levels in the southern portion of Black Lake. North Line Canal conveys large volumes of water from wind-induced high-tide areas within the Sabine NWR toward Sabine Lake by way of Black Bayou (Paille, 1996).

During prolonged periods of strong northerly winds (typically occurring after frontal passage), water levels in the nearshore Gulf and within Calcasieu and Sabine lakes lower, often resulting in a continuous outflow from Calcasieu and Sabine lakes. The large area of marsh and shallow open water extending northward from Backridge Canal to Hackberry can also experience a push of water southward and, thus, raising water levels in the southern end of the open water and lowering water levels in the northern end. This southward push of water in the open water often results in a strong flow toward Calcasieu Lake due

FIGURE 3.5-1

MAP OF HYDROLOGIC CONNECTIONS BETWEEN SABINE LAKE AND CALCASIEU LAKE



Source: Paille, 1996

to the lowering water levels in the lake caused by the outgoing flows. The Backridge and Roadside canals can convey large volumes of water from the high-water-level areas toward Calcasieu Lake via Headquarters Canal and West Cove Canal water structures. Flow patterns in Rycade Canal can vary, however, with the North Line Canal west of Beach Canal typically draining west toward Sabine Lake (Paille, 1996).

During summer months, when winds are typically light and variable, lunar tides generally dominate the flows between Calcasieu and Sabine lakes. Normal flow patterns for ebb tides are similar to frontal passage and for flood tides are similar to conditions prior to frontal passage, but in smaller magnitudes. During ebb tide, GIWW, North Line Canal, Central Canal, and South Line Canal drain the Sabine NWR marsh area simultaneously toward both Calcasieu and Sabine lakes, with no-flow sections in each canal that vary with wind, water levels, river stages, and control-structure operation (Paille, 1996).

3.5.3 Flow Diversion, Demands and Discharges

3.5.3.1 Flow Diversions

Flow patterns and salinity in Sabine Lake, surrounding marshes, and tributaries have changed as a result of navigational dredging. In 1876, a sandbar was removed from Sabine Pass to aid in navigation, which consequently facilitated saltwater intrusion into Sabine Lake (USACE, 1975a, 1998a). Since then, channel deepening and widening has exacerbated saltwater intrusion into Sabine Lake and surrounding marshes and tributaries. In addition, Sabine Lake, Calcasieu Lake in Louisiana, and surrounding waterbodies have been connected through man-made canals and the GIWW. Tidal currents emanating from the Gulf transport seawater through Sabine Pass into Sabine Lake and adjacent waterbodies. Although the lake and associated waterbodies are low-energy environments, wind-generated currents strongly influence water movement within the system (Paille, 1996). As a result, a complex hydraulic relationship has developed within this area.

Several saltwater barriers in the study area restrict saltwater intrusion into upstream areas. In Texas, along Taylor Bayou, two saltwater barriers and sets of navigation locks are located approximately 2 miles upstream of the mouth of Taylor Bayou. Originally installed for irrigation purposes, the saltwater barriers along Taylor Bayou now primarily serve as a preventative measure for stopping saltwater intrusion into freshwater marshes and maintaining water level for recreation purposes (JCND, 2002). Additionally, the TPWD also maintains several small saltwater barriers in various locations along the GIWW for the purpose of protecting freshwater marshes and habitat within the J.D. Murphree WMA (JCND, 2002). Saltwater intrusion from the GIWW is controlled by water control structures at Perkins Levee and the opening of Salt Bayou to the GIWW (USACE, 1992), but the marshes remain open to the salinity influence of the SNWW through the Keith Lake Fish Pass. The GIWW structures are manually controlled by the TPWD and can be opened to help drain the area when the marshes have been flooded with higher-salinity waters during hurricanes. In the Texas Point NWR, low rock weirs have been constructed on several small channels in the intermediate and brackish marshes; however, unrestricted flow still is provided through the largest stream in the hydro-unit, Texas Bayou.

The area within the Calcasieu/Sabine River Basin has experienced accelerated marsh deterioration and conversion to shallow open water as a result of the construction of the Calcasieu Ship Channel, the SNWW, and the GIWW. Efforts to combat the increased flow of salt water into the area include both structural and vegetative methods. A 1990 inventory of water control structures along the perimeter and interior of the Calcasieu/Sabine River Basin located 174 structures. Examples of these water-control structures include (Marcantel, 1996):

Location	Description
Louisiana SH 82 at Calcasieu Ship Channel	Three-barrel structure allows only one-way flow into Calcasieu Ship Channel
Louisiana SH 27 at Holly Beach, Louisiana	Two-barrel structure allows only one-way flow into the roadside ditch along Louisiana SH 82
Structure at First Bayou	Bulkhead structure with two bays managed so that two-way flow is possible until salinity levels reach or exceed 7 ppt in the road ditch along west Louisiana SH 27
Hog Island Gully	Fixed crest weir with tainter arm gate that remains open until salinity levels reach 12 ppt in Brown Lake (on the north end of the Sabine NWR)
West Cove Canal	Fixed crest weir with tainter arm gate that remains open until salinity levels reach 12 ppt in Back Ridge Canal of the West Cove Canal structure
Headquarters Canal	Single-barrel structure where gates remain open until salinity levels reach or exceed 12 ppt in Brown Lake
Rycade Canal	Bulkhead structure with seven bays managed so that flap gates are allowed to operate when water levels in interior marshes are above marsh level and/or salinity at the structure reaches or exceeds 5 ppt
Gray’s Ditch Levee/Cattle Walkway	Levee has two openings (one at unnamed bayou and one at Willow Bayou) and forms a barrier along the east bank of Sabine Lake
Deep Bayou	Two-barrel structure allows one-way flow out of Deep Bayou into Johnson’s Bayou
South Starks Canal	Three-barrel structure allows one-way flow to the east

More recently, two CWPPRA hydrologic restoration projects have been completed in the Black Bayou and Willow Bayou marshes east of Sabine Lake:

- The East Sabine Lake Hydrologic Restoration Project (CWPPRA Project No. CS-32), approved in 2001, has nearly been completed (USGS-NWRC, 2004). Project goals include the reduction of salinities within interior marshes, encouragement of submerged aquatic vegetation (SAV) development, hydrologic restoration of historic flows, reduction of turbidity in open-water areas, and the restoration and protection of marsh through earthen vegetative terraces. Construction Unit 1, completed in 2006, includes a rock weir at Pines Ridge Bayou, two flapgate culverts at Bridge Bayou, a rock plug at Double Island Gully, a 3,000-foot-long foreshore rock dike along the Sabine Lake shore north of Willow Bayou, and approximately 32 miles of vegetated earthen terraces in large shallow open-water areas south of Greens Lake and south of Willow Bayou Canal. Hydrodynamic modeling of proposed Construction Unit II water control structures (fixed crest weirs with boat bays) at Right Prong, Greens, Three, and Willow bayous was completed in 2004 (USFWS-LDNR, 2008a). The modeling predicted that the proposed structures would have very little effect on reducing project area salinities, and therefore Construction Unit 2 components were deleted from the restoration plan in 2006. The Pines Bayou weir was rehabilitated in 2007 due to heavy damage from Hurricane Rita. Four 50-foot-wide gaps were also installed in 2007 in the breakwater near Willow Bayou. Additional in situ earthen terraces are also planned.

- The Black Bayou Hydrologic Restoration Project (CWPPRA Project No. CS-27) was constructed in 2001 for the purpose of restoring coastal marsh habitat and slowing the conversion of wetlands to shallow open water. The project limits the amount of saltwater intrusion into the surrounding marsh and canals from Black Bayou and the GIWW and reduces erosion caused by wave action from nearby boats and tides (USGS-NWRC, 2002c). These elements are (1) approximately 4.3 miles of rock foreshore dike along the south shore of the GIWW; (2) the Black Bayou Cut-off Canal rock weir with boat bay; (3) the Burton Canal weir with boat bay; (4) the Block's Creek rock weir with boat bay; and (5) a self-regulating tide gate for the NO-13 unit wetlands. The objective of the tide gate is to divert fresh water from the GIWW and create a hydrologic head that maximizes freshwater retention time and reduces saltwater intrusion and tidal action. Terracing and vegetative plantings are also planned as part of the CWPPRA project.

Flows into Sabine Lake have been greatly altered from their natural hydrograph due to major impoundments in the middle and upper Sabine and Neches river basins. The flow regime of the lower Sabine River is affected by Toledo Bend Reservoir, which provides electric power, flood control, and irrigation water. Playing a lesser role, but nevertheless affecting water availability in the Sabine River, are a number of smaller reservoirs upstream of Toledo Bend Reservoir in Texas. The larger of these impoundments include lakes Tawakoni, Fork, Cherokee, Martin Creek, and Murval. Additionally, the flow regime of the lower Sabine River is affected by two diversion canals near Sulphur, Louisiana, which were constructed to provide municipal, industrial, and irrigation water to Calcasieu Parish in Louisiana and Orange County in Texas. The diversion pumps currently operate at 20 percent of their capacity that results in an average daily flow of 336 cfs to Calcasieu Parish and 560 cfs to Orange County.

The flow regime of the Neches River is strongly influenced by Sam Rayburn Reservoir and to a lesser extent by B.A. Steinhagen Reservoir. Other reservoirs that affect water availability within the Neches River are upstream of Sam Rayburn Reservoir and include lakes Palestine, Tyler, Jacksonville, Striker, and Nacogdoches.

Saltwater intrusion in the Neches River became a problem with the construction of the first deepwater navigation channel to Beaumont in 1915 (USACE, 1998a). Since that time, salt water has threatened freshwater intakes on the Neches River. In the past, temporary saltwater barriers and freshwater discharges (up to 2,500 cfs) from Sam Rayburn Reservoir were used to prevent encroachment of salt water (Lower Neches Valley Authority [LNVA], 2002; USACE, 1998a). A saltwater barrier was constructed on the Neches River immediately downstream of the confluence of the Neches River and Pine Island Bayou (USACE, 2004b). Operation of the new saltwater barrier will preclude the need for large freshwater releases from Sam Rayburn Reservoir during periods of drought, resulting in a net reduction of freshwater inflow into Sabine Lake (LNVA, 2002; Mosier, 2002). However, provisions for maintaining environmental flows to protect high-quality wetlands downstream of the saltwater barrier during periods of drought are currently being developed (Mosier, 2002). Under this plan, special gate operations for wildlife and environmental management will be coordinated with the USACE. This will include providing enough freshwater inflow to maintain a specific conductance of 2,800 microsiemens or less (within 10 feet of the surface) at the IH 10 bridge near Beaumont. While freshwater habitats in the Neches River will be maintained by the operation of the new saltwater barrier, it is likely that freshwater inflows into Sabine Lake will be less under drought conditions than historical inflows.

In May 2007, the Texas House of Representatives and Senate passed HB3 and SB3, respectively, which was signed by the Governor on June 15, 2007 (Texas Legislature Online [TLO], 2007). The "Environmental Flows" Act took effect on September 1, 2007 (TLO, 2007). The Act creates an administrative process to determine environmental flow needs for the rivers, bays, and estuaries of Texas. After the needs are established, TCEQ is required to develop and adopt rules to (1) provide environmental flow standards necessary to support the ecology of every river and bay system in Texas; (2) establish an amount of unappropriated water that would be set aside for satisfying the environmental flow standards; and (3) create a process for reducing the amount of water that would be available under a water rights permit, issued after the bill's effective date, to protect the environmental flow standards. TCEQ identified the lower Sabine River as one of the first tier of instream flow studies to be initiated. TCEQ has contracted with the Sabine River Authority of Texas (SRA-TX) for assistance in the Lower Sabine Priority Instream Flow Study. Based on the results of this study, TCEQ will establish environmental flow standards for the Sabine River/Neches River/Sabine Lake system by September 1, 2010.

3.5.3.2 Freshwater Demands and Discharges

Water demands and supplies have been analyzed for the East Texas Region (Region I), consisting of 20 counties as far north as Smith County that includes the City of Tyler (TWDB, 2007). The projected regional water demand for the year 2010 is 896,455 acre-feet. Manufacturing represents 45 percent of the amount and irrigation is 25 percent. Municipal and county demand represents 21 percent of that amount. This demand is projected to increase by 41 percent by the year 2060. Water supply projected for 2010 is 1,158,261 acre-feet, with 80 percent of the supply from surface water. The remainder of the supply is from groundwater. While demand is projected to slightly exceed the existing supply by the year 2060, the recommended water management strategy for the region would result in an additional 324,756 acre-feet of supply (TWDB, 2007). The plan anticipates expanded exports of water to Region C (Dallas-Fort Worth area).

During dry conditions, stream flow is influenced by the discharge from permitted wastewater treatment plants or point sources along tributaries. For the Neches-Trinity Coastal Basin, which includes Taylor Bayou, there are 89 permitted point sources that have a combined permitted flow of 214 million gallons per day (MGD), or 330 cfs. The Neches River Basin has 225 point sources for a combined permitted flow of 1,341 MGD, or 2,070 cfs; and the Sabine River Basin has 166 point sources for a combined permitted flow of 1,647 MGD, or 2,550 cfs. While actual discharges are usually much smaller than the permitted flows, and not all of these point sources are located within the study area, some of the discharges would affect salinity levels in the study area during drought periods.

3.5.4 Tides

Tides in the SNWW and Sabine Lake are dominated by the tides emanating from the Gulf, but lag by about 1 hour from offshore to Sabine Pass and by 4 to 5 hours from offshore to the upper reaches of the SNWW. Normal tidal fluctuation in the study area is small with a diurnal range of 1 to 2 feet (Mantz and Dong, 1996).

The Texas Coast Ocean Observation Network (TCOON) maintains tide gauge stations at Sabine Pass, Mesquite Point, Port Arthur, Rainbow Bridge, and Orange. These gauges vary in length of record from 5 to 10 years. The statistics of tidal records at these TCOON gauges can be found on the TCOON website (http://lighthouse.tamucc.edu/TCOON/HomePage). A tidal range varying from 1.03 feet at Sabine Pass to 0.65 foot at Orange can be derived from the tide records. These ranges are typical of the Gulf coast area.

Water levels in the SNWW are also influenced by the prevailing winds from the south-southeast. Water levels generally rise slightly with winds out of the south and south-southeast and fall, sometimes significantly, with winds from the north or northwest. Water surface elevations in the SNWW can vary greatly when driven by wind and storm activity. Water levels as low as –4 feet during strong northwesterly winds and as high as +16 to +18 feet during hurricane surges have been observed.

3.5.5 SNWW and Salinity

Tidal flow originating from the Gulf influences the tidal regime of the SNWW, including Sabine Lake and Calcasieu Lake. During periods of drought, the flow in the Neches and Sabine rivers can drop drastically and a saltwater wedge can proceed farther upstream of both the Sabine and Neches rivers from the Gulf (LNVA, 2002; SRA-TX, 2002). While saltwater intrusion has been detected in salinity samples in the Sabine River Tidal reach, a definite saltwater wedge has not been identified because of the fluctuation of freshwater inflows from upstream. A definite saltwater wedge is evident in the Neches River, and a new saltwater barrier located approximately 30 stream-miles upstream of Rainbow Bridge has been installed to prevent saltwater intrusion north of the Port of Beaumont (see subsection 3.5.3.1 for additional discussion).

The strength and intensity of winds and intensity of rainfall influences salinity levels in the SNWW, Sabine Lake, and Calcasieu Lake. The salinity of the water ranges from approximately 34 ppt in the open Gulf to 0 ppt in the upper reaches of the Neches and Sabine rivers. Sabine Lake is predominantly brackish with salinity ranging from 15 ppt at Sabine Pass to 0 ppt at the northern end of the lake near Rainbow Bridge. Calcasieu Lake is also brackish, but generally experiences salinity levels higher than those found in Sabine Lake. Given that both lakes are tidally influenced and water exchange patterns between the two lakes vary with tides and wind, the fluctuating salinity levels can often be extreme. The Sabine NWR and the waterways connecting the two lakes also experience fluctuating salinity levels, however, generally, not in the extremes observed within the two lakes. Sabine Lake relies on freshwater inflow from the Neches and Sabine rivers, while Calcasieu Lake relies primarily on the Calcasieu River for freshwater inflow. The Sabine NWR relies primarily on rainfall for fresh water, and its salinity increases during periods of drought as the salinity in the two lakes rises (Paille, 1996).

During drought periods, salt water can travel more easily through the deeper SNWW than shallower Sabine Lake, thus the northern reach of the lake and associated marshlands can have the unique condition of having greater salinity levels than those areas to the south. This is because salt water traveling in the SNWW can enter northern marshes that typically have salinity levels buffered by freshwater inflows from the Sabine and Neches rivers. Saltwater entering the northern marshes can result in build-up of salinity concentrations. During periods of normal rainfall, high-salinity water transported by the SNWW is buffered by discharges from upstream reservoirs that have little effect on the salinity levels of Sabine Lake and the surrounding marshes. On the other hand, during periods of high flows, the SNWW and Sabine Lake can experience occasional freshwater conditions (very low salinity levels) due to large quantities of fresh water entering the system from the Sabine and Neches rivers (Coalition to Restore Coastal Louisiana, 2002).

Fifty-six stations provide salinity data measured from the monitoring stations within the study area. Data from the stations can be obtained from TCEQ's Standard Water Quality Monitoring (SWQM) database, which is used to support the Texas Clean Rivers Program and the preparation of Texas Water Quality Inventory (TCEQ, 2002). The locations of these stations range from the USCG station in Sabine Pass upstream to all the tributaries (e.g., Black Bayou, Cow Bayou, Adams Bayou) to the upper reaches of the Neches and Sabine rivers in the study area, and in the GIWW east of the Sabine River and west of Port Arthur. Salinity, as a function of depth from several stations along the SNWW, is of particular interest because the heavier salt water tends to move upstream along the bottom of the deep, stratified channel while freshwater flowing on top of the saltwater current moves downstream. The data from the project area show a clear trend of reduced bottom salinity when moving upstream along the SNWW, from about 25 ppt at Sabine Pass to about 15 ppt at IH 10 on Neches River near Beaumont and 10 ppt at the upper portion of Sabine Lake near the confluence with the Sabine River. The stations at the GIWW (about 7 miles upstream of Sabine Pass) and at Topco Dock (about 6 miles upstream of the GIWW) have bottom salinities of about 23 ppt and 20 ppt, respectively. These values clearly show the level and extent of salinity intrusion along SNWW.

3.5.6 Groundwater Hydrology

Groundwater in the project area is withdrawn from the Gulf coast aquifer system. The Gulf coast aquifer consists of complexly interbedded clays, silts, sands, and gravels of Cenozoic age, which are hydrologically connected to form a large, leaky artesian aquifer system that extends from the Rio Grande northeastward across the Gulf Coastal Plain past the Louisiana-Texas border. In the project area, the Gulf coast aquifer is subdivided into several parts, of which the Chicot aquifer is the uppermost (Figure 3.5-2). The Chicot aquifer consists of the Willis, Lissie (Montgomery and Bently), and Beaumont formations, and overlying alluvial deposits. The Chicot aquifer includes all deposits from the land surface to the top of the underlying Evangeline aquifer. The physical basis for separation of the Evangeline and Chicot aquifers is the difference in lithology and permeability (Wesselman, 1971). In some area, clay beds

Figure 3.5-2. Geologic and Hydrologic Units within the Project Area

<table>
<tr><th rowspan="2">System</th><th rowspan="2">Series</th><th colspan="3">Stratigraphic Unit</th><th colspan="3" rowspan="2">Hydrologic Unit</th></tr>
<tr><th colspan="2">Texas</th><th>Louisiana</th></tr>
<tr><td rowspan="5">Quaternary</td><td>Holocene</td><td colspan="2">Quaternary Alluvium</td><td>Quaternary Alluvium</td><td rowspan="5">Chicot Aquifer</td><td rowspan="3">Upper Unit</td><td rowspan="7">Gulf Coast Aquifer</td></tr>
<tr><td rowspan="4">Pleistocene</td><td colspan="2">Beaumont Clay</td><td>Prairie Formation</td></tr>
<tr><td rowspan="2">Lissie Formation</td><td>Montgomery Formation</td><td>Montgomery Formation</td></tr>
<tr><td>Bently Formation</td><td>Bently Formation</td><td rowspan="2">Lower Unit</td></tr>
<tr><td colspan="2">Willis Sand</td><td>Willianna Formation</td></tr>
<tr><td rowspan="2">Tertiary</td><td>Pliocene</td><td colspan="2">Goliad Sand</td><td>Foley Formation</td><td colspan="2">Evangeline Aquifer</td></tr>
<tr><td>Miocene</td><td colspan="2">Fleming Formation</td><td>Fleming Formation</td><td colspan="2">Burkeville Aquiclude</td></tr>
</table>

separate the aquifers, but these beds are not continuous. The higher permeabilities are usually associated with the Chicot aquifer.

The Chicot aquifer has been divided into an upper unit and lower unit. These units are separate by a clay bed; however, in some parts of the study area, the upper and lower units merge to form one large mass of interbedded and interconnected sand and clay. The upper unit of the Chicot typically consists of a basal sand overlain by clay. Most of the sand is part of the Montgomery Formation, and the clay is part of the overlying Beaumont Formation. The lower unit generally consists of two or more massive sands separated by clay. Northwestward, the sands thin and the clay content of the lower unit increases.

The Evangeline aquifer underlies the Chicot aquifer and is the lowermost unit containing fresh to slightly saline groundwater within the project area (see Figure 3.5-2). The Evangeline aquifer consists of the Goliad Sand and upper portions of the Fleming Formation. The aquifer is underlain by the Burkeville aquitard, which forms the lower confining unit for the Evangeline aquifer.

Water well records kept by the TWDB for Orange and Jefferson counties indicate that the majority of water wells in the project area are completed in the upper and lower units of the Chicot aquifer. Of the wells installed in the Chicot, most are completed in the lower unit typically at depths between 400 and 800 feet. Wells completed in the upper unit of the Chicot aquifer were typically completed at depths ranging from 15 feet or less to 300 feet. Groundwater is reportedly used for domestic, public supply, stock, and industrial purposes.

Groundwater recharge to the aquifers occurs by precipitation onto outcrop areas and vertical leakage from overlying aquifers. However, most precipitation runs off and becomes stream flow or evaporates immediately and only a small fraction of the total rainfall recharges the surficial aquifer. Regional groundwater flow in the aquifers is generally southeastward from outcrop areas towards areas of natural discharge (Gabrysch and McAdoo, 1972; Wesselman, 1971). However, superimposed upon this natural discharge regime is artificial discharge caused by groundwater pumping. Because of groundwater development, water levels have declined and cones of depression around areas of groundwater pumping have developed altering the natural flow pattern, and groundwater now flows towards these centers of pumping.

Groundwater quality in the Chicot aquifer varies widely across the study area. In general, the water in the aquifer increases in salinity in the southern part of the study area near the coastline. Groundwater quality data from the TWDB database indicate that groundwater from water wells completed in the Chicot aquifer within the project vicinity generally has total dissolved solids (TDS) concentrations less than 200 mg/L (fresh) to more than 3,000 mg/L (slightly to moderately saline). Most of the groundwater from the Chicot aquifer has an average TDS concentration of less than 1,500 mg/L. Chloride concentrations typically ranged from less than 50 mg/L to over 600 mg/L and averaged around 450 mg/L.

3.5.7 Erosion

Several locations in the study area are experiencing significant erosion: the side of Pleasure Island bordering the Port Arthur and Sabine-Neches canals, the eastern shore of Sabine Lake, and the Gulf shoreline in Texas and Louisiana. Each of these areas is discussed below.

The rate of erosion of the Pleasure Island shoreline varied between 4.2 and 16.5 feet per year during the 20-year period 1974 through 1993 (Parchure et al., 2005). Erosion appears to be caused predominantly by surges, stern waves, and rapid drawdown resulting from vessel traffic within the constricted Sabine-Neches waterway (Maynord, 2005). The fetch is limited for the constricted waterway; wind waves are, therefore, relatively small in magnitude and not likely to contribute significantly to existing erosion rates. In addition, the highly erodible and weakly compacted soil on Pleasure Island makes it vulnerable to erosion from any source.

Marsh loss caused by wind-induced wave action is also occurring along the east Sabine Lake shoreline north of Willow Bayou at an average rate of 4.7 feet/year (Greco and Clark, 2005). Visual observations and GIS analyses confirm that the shoreline near the Willow Bayou mouth has shifted towards Willow Bayou leaving a narrow strip of land, which may be on the order of only 30 to 50 feet wide, separating Willow Bayou and Sabine Lake. Tall natural grass grown on this strip of land has not been able to arrest the erosion because the grass roots are not able to hold the soil firmly attached to them. Sabine Lake has a large water surface area, which provides sufficient fetch for significant wave generation and, in the shallow-water depths, the waves breaking on the shore have sufficient energy to cause serious erosion.

Texas Point is undergoing severe beach erosion, with shoreline retreat of up to 1,150 feet between 1974 and 2000 (King, 2007; Morang, 2006). This is the highest rate of shoreline loss on the upper Texas coast and a CEPRA "critical erosion area" (GLO, 2005). In Louisiana, persistent erosion along the shoreline between Ocean View and Holly Beach, on the order of –4.3 feet/year between 1985 and 1998, was recorded here prior to Hurricane Rita (USACE, 1971a, 2004a). Nearer to Louisiana Point, significant accretion over the last 100 years has slowed to +1.2 feet/year, and the behavior of this shoreline has become erratic, with some areas eroding and some aggrading (USACE, 2004a). Hurricane Rita deposited 3.3 feet of new sediment on the Hackberry Beach chenier ridge, and reworked sediment was observed bar welded to the lower shoreface (Farris et al., 2007; Guidroz et al., 2006). Hurricane Ike eroded the beach ridge at the McFadden NWR (Federal Emergency Management Agency, 2008). Impacts to this ridge increase the probability that interior marshes will be exposed to saltwater intrusion in the near future.

3.6 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

The purpose of the HTRW assessment is to identify indicators of potential hazardous materials or waste issues relating to the study area. A review was conducted of databases maintained by Federal, State, and local regulatory agencies, an aerial photographic review, and interviews with officials from the TCEQ and the USACE to determine the location and status of HTRW sites regulated by the State of Texas and the EPA. A review was also conducted of oil and gas wells and pipelines located within the study area. These data were obtained from the Texas Railroad Commission (RRC) and the LDNR. Support data for the assessment can be found in PBS&J (2002).

The scope of the regulatory information search included the following Federal and State databases: the National Priority List (NPL); the State Equivalent Priority Sites (State Sites or SPL); Comprehensive Environmental Response Compensation and Liability Information System (CERCLIS) Database; Resource Conservation and Recovery Act (RCRA) Generators and Violators List (RCRA-G); RCRA Corrective Actions List (CORRACT); RCRA Treatment, Storage, or Disposal List (RCRA-TSD); TCEQ and LDEQ Underground and Aboveground Storage Tank Database; Leaking Underground Storage Tank Listings (LUST); City/County and Parish Solid Waste Landfill listings (SWL); Emergency Response Notification System (ERNS) database; TCEQ and LDEQ Spills Incident Information System database; National Pollution Discharge Elimination System (NPDES) database; Toxic Release Inventory System (TRIS) database; and Facility Index System (FINDS) database. A total of 1,789 records were identified within the study area during the various regulatory agency database searches. Several of the records are associated with the same facility or property (e.g., a facility/property containing multiple petroleum storage tanks is also the site of several reported spills or emergency response actions). The 1,789 database records are associated with a total of 598 facilities or properties within the study area. On the basis of results of the regulatory agency database searches, the following sites are located within the study area:

- 4 NPL sites;
- 33 CERCLIS sites, 30 sites with No Further Remedial Action Planned designation;
- 9 CORRACT sites;
- 151 RCRA-G sites;
- 11 RCRA-TSD sites;
- 776 petroleum storage tanks at 289 facilities;
- 74 LUST sites;
- 4 State Voluntary Cleanup sites;
- 515 reported ERNS actions at 93 facilities/properties;
- 414 reported spills at 22 facilities/properties;
- 45 TRIS listings associated with 30 facilities;
- 221 FINDS database listings associated with 207 facilities/properties; and
- 2 unpermitted (inactive) municipal SWL.

Aerial photographs of the study area were used to examine the historical use of the SNWW and the surrounding watershed. The photographs depict portions of the study area as it appeared in 1930, 1938, 1955, and 1956. The aerial photographs were obtained from Tobin International, Ltd. Examination of aerial photography indicated that development within the study area was, as it is today, predominantly located west of the Sabine and Neches rivers. Development occurs in the urban centers of Texas that include Beaumont, Port Arthur, Port Neches, Nederland, Orange, West Orange, Bridge City, and Rose City. The remainder of the Texas portion of the study area is vacant, undeveloped land. With the exception of Vinton, the Louisiana portion of the study area is vacant, undeveloped land. The study area includes a variety of land uses, which include highly developed residential-urban, industrial, recreational, and vacant, undeveloped range-pasture or WMAs.

Urban development within the study area is located adjacent to major highways. An industrial corridor composed of petroleum refineries, petrochemical plants, ship docks, shipyards, ship builders, grain elevators, PAs, warehouses, wastewater treatment plants, and a power plant parallels the SNWW. Utilization of vacant, undeveloped land is for agriculture and oil and gas production. For additional discussion on land use, see subsection 3.14.4.

According to information derived from regulatory agency records and TCEQ regional officials, regional industrial activity has caused measurable impacts to the surface water, sediment, soil, and groundwater in the study area. However, chemical analyses of sediment, elutriate, and surface water samples collected from the waterway indicate that these impacts have apparently been minimal (sections 3.3 and 3.4). The nature and potential for any HTRW site to impact the surrounding environment varies considerably. The majority of the regulated facilities and incident locations (i.e., spills and releases) identified in the regulatory agency database review do not pose a significant environmental concern for the project. However, several facilities within the study area do have a greater potential to impact the environment. These facilities are considered a potential threat based on the nature and extent of contaminants at the site, the location relative to the waterway, and the number of pathways in which the contaminants could reach the waterway. The facilities that are considered priority HTRW sites of concern are summarized in Table 3.3-1.

A baseline evaluation of facilities that pose a potential threat to the project must also consider whether the release of contaminants is ongoing or has been effectively eliminated through remedial efforts. Based on these criteria, State Marine, Palmer Barge Lines, Star Lake Canal, and Beaumont Elevator continue to present an ongoing threat to impact the environment of the study area. The remaining priority sites present a lesser threat due in part to either effective corrective action or distance to the waterway. Detailed site information of each of these facilities is provided in PBS&J (2002).

State Marine (Site ID No. 203) and Palmer Barge Lines (Site ID No. 548) are located on Pleasure Islet south of channel station 250+00 and north of PA 11. These sites are reported to have impacted surface water and are currently undergoing cleanup and evaluation. Star Lake Canal (Site ID No. 471) is located adjacent to the boundary of the cities of Port Arthur and Port Neches, Texas, and midway between PAs 16 and 17. The canal conveys stormwater and industrial wastewater from adjoining industrial facilities and discharges the water to the Neches River near the midpoint of channel stations 130+00 and 230+00. The canal is reported to have impacted surface water and is currently undergoing cleanup and evaluation. The Beaumont Elevator (Site ID No. 113) is located at 1745 Buford Street and adjacent to the waterway west of channel station 930+00. The site is reported to have impacted soil and groundwater and is currently undergoing an investigation.

The Star Lake Canal priority site has potential to affect PA 17. PA 17 is located adjacent to the Neches River in Port Neches, Texas, at river station 260+00. The 392-acre parcel on the west bank of the Neches River has been used as a PA for dredged material for over 40 years. A recent environmental survey of the property identified Recognized Environmental Conditions on the tract including a capped landfill, waste disposal areas containing unknown substances, asbestos-containing material, lead, and furfural. These sites are located inside and close to the southwest boundary of PA 17.

Also, another potential HTRW concern has been identified on adjoining land. A recently updated EPA Region 6 fact sheet (EPA Publication date March 6, 2006) for the Star Lake Canal Superfund Site indicates the Potentially Responsible Parties are planning Remedial Investigations (RI) and a study to determine the nature and extent of contamination. Heavy metals, PCBs, and PAHs have been identified as having migrated or have the potential to migrate to Molasses Bayou, Star Lake Canal, the Neches River, and Sabine Lake. Pentachlorophenol and toxaphene have been found in Jefferson Canal sediments (EPA, 2006). The preliminary area of concern lies outside the eastern and southern boundaries of PA 17.

The Star Lake Canal Superfund site consists of contaminated surface water and sediments in the Star Lake Canal, adjoining Jefferson Canal, and Molasses Bayou (EPA, 2006). The Jefferson Canal and the Star Lake Canal have served as industrial wastewater and stormwater outfalls since the late 1940s. Although the Star Lake Canal borders PA 17, the current configuration of PA 17 distances it from the canal. PA 17 has been leveed to contain dredged material for at least 36 years, as indicated by a 1969 aerial photo. The levee system also acts as a barrier to encroachment of surface water and sediments outside the PA.

RRC files indicate that there are a total of 6,951 permitted well sites located within the study area. These well sites include 6,073 vertical wells and 878 directional wells. The database indicates that the vertical well sites include the following types/status:

- 1,370 are listed as active producing oil/gas wells;
- 2,372 as plugged;
- 1,861 as dry holes;
- 7 as permitted locations;
- 158 as shut-in wells;
- 35 as storage wells;
- 57 as injection wells;
- 28 as saltwater disposal wells;
- 1 as a brine mining well; and
- 184 well sites listed as miscellaneous well types.

One thousand ninety-eight of the producing vertical wells are listed as oil wells, 168 are listed as gas wells, and 104 are listed as producing oil and gas.

The database indicates that directional well sites include the following types/status:

- 226 active producing oil/gas wells;
- 291 plugged wells;
- 202 dry holes;
- 10 injection wells;
- 5 permitted locations;
- 90 shut-in wells;
- 2 storage wells;
- 8 saltwater disposal wells;
- 1 brine mining well; and
- 43 well sites were listed as the miscellaneous well types.

One hundred fifty-eight of the producing directional wells are listed as oil wells, 50 are listed as gas wells, and 18 are listed as producing oil and gas.

A total of 533 pipeline systems were identified within the study area. Five hundred seventeen (517) of the pipelines are listed as active, 16 are listed as inactive. The pipelines are reported to transport the following material:

- 314 transport natural gas;
- 49 crude oil;
- 91 oil and gas;
- 8 LPG;
- 161 gas and condensate; and
- 1 pipeline system was listed as idle.

While the RRC pipeline database is the most comprehensive account of pipelines in the State of Texas, this database does not include every existing pipeline. Therefore, a remote sensing survey for pipelines, wells, and other obstructions in the SNWW navigation channel has been conducted (PBS&J, 2005); field survey data have been matched with the results of record searches that are reported in PBS&J (2002).

3.7 AIR QUALITY

3.7.1 Regulatory Context

The Clean Air Act (CAA), which was last amended in 1990, regulates air emissions from area, stationary, and mobile sources. The CAA requires the EPA to establish National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment and establishes two types of national air quality standards. Primary standards define the maximum levels of air quality that the

EPA judges necessary, with an adequate margin of safety, to protect public health, including the health of "sensitive" populations such as asthmatics, children, and the elderly. Secondary standards define the maximum levels of air quality that the EPA judges necessary to protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings. Air quality is generally considered acceptable if pollutant levels are less than or equal to these established standards on a continuing basis.

The EPA has established NAAQS for seven principal pollutants, called "criteria" pollutants, in 40 Code of Federal Regulations (CFR), Part 50. The criteria pollutants are carbon monoxide (CO), nitrogen dioxide (NO_2), ozone (O_3), lead (Pb), inhalable particulate matter (PM) with an aerodynamic diameter less than or equal to a nominal 10 microns (PM_{10}), fine particulate matter with an aerodynamic diameter less than or equal to a nominal 2.5 microns ($PM_{2.5}$), and sulfur dioxide (SO_2). These standards are summarized in Table 3.7-1.

Table 3.7-1
National Ambient Air Quality Standards

Air Constituent	Averaging Time	NAAQS Primary	NAAQS Secondary
Sulfur Dioxide (SO_2)	3 hours 24 hours Annual Arithmetic Mean	0.50 ppm 0.14 ppm 0.030 ppm	0.5 ppm
Particulate Matter (PM_{10})	24 hours	150 $\mu g/m^3$	150 $\mu g/m^3$
Particulate Matter ($PM_{2.5}$)	24 hours Annual Arithmetic Mean	35 $\mu g/m^3$ 15 $\mu g/m^3$	35 $\mu g/m^3$ 15 $\mu g/m^3$
Nitrogen Dioxide (NO_2)	Annual Arithmetic Mean	0.053 ppm	0.053 ppm
Carbon Monoxide (CO)	1 hour 8 hours	35 ppm 9 ppm	--- ---
Lead (Elemental) (Pb)	Calendar Quarter Arithmetic Mean	1.5 $\mu g/m^3$	1.5 $\mu g/m^3$
	Rolling 3-Month Average	0.15 $\mu g/m^3$	0.15 $\mu g/m^3$
Ozone (O_3)	1 hour 8 hour (1997 standard) 8 hour (2008 standard)	0.12 ppm 0.08 ppm 0.075 ppm	0.12 ppm 0.08 ppm 0.075 ppm

Source: 40 CFR, Part 50, National Primary and Secondary Ambient Air Quality Standards.
--- = An ambient air quality standard has not been promulgated.
ppm = parts per million.
$\mu g/m^3$ = micrograms per cubic meter.

CO is a colorless and practically odorless gas primarily formed when carbon in fuels is not burned completely (Lewis, 1987). It may temporarily accumulate at harmful levels, especially in calm weather during winter and early spring, when fuel combustion may reach a peak and CO is chemically more stable due to the low temperatures. Transportation activities, indoor heating, industrial processes, and open burning are among the anthropogenic (man-made) sources of CO.

NO_2, nitric oxide (NO), and other oxides of nitrogen are collectively called nitrogen oxides (NO_x). These compounds are interrelated, often changing from one form to another in chemical reactions. NO_2 is commonly measured in ambient air monitors. NO_x emissions are generally emitted in the form of NO, which is oxidized to NO_2. The principal anthropogenic sources of NO_x are fuel combustion in motor vehicles and stationary sources such as boilers and power plants. Reactions of NO_x with other atmospheric chemicals can lead to the formation of O_3.

Ground-level O_3 is a secondary pollutant, formed from daytime reactions of NO_x and (volatile organic compounds (VOCs) rather than being directly emitted by natural and anthropogenic sources. VOCs are released in industrial processes and from evaporation of organic liquids such as gasoline and solvents. Ozone contributes to the formation of photochemical smog.

Pb is a heavy metal that may be present as dust or fumes. Dominant industrial sources of Pb emissions include waste oil and solid waste incineration, iron and steel production, lead smelting, and battery and lead alkyl manufacturing. The lead content of motor vehicle emissions, which was the major source of lead in the past, has significantly declined with the widespread use of unleaded fuel.

The NAAQS for particulate matter is based on two different particle diameter sizes: PM_{10} and $PM_{2.5}$. PM_{10} are small particles that are likely to reach the lower regions of the respiratory tract by inhalation. $PM_{2.5}$ is particulate matter that is considered to be in the respirable range, meaning these particles can reach the alveolar region of the lungs and penetrate deeper than PM_{10}. There are many sources of particulate matter, both natural and anthropogenic, including dust from natural wind erosion of soil, construction activities, industrial activities, and combustion of fuels.

SO_2 is a colorless gas with a sharp, pungent odor (Lewis, 1987). SO_2 is emitted in natural processes, such as volcanic activity, and by anthropogenic sources such as combustion of fuels containing sulfur and the manufacture of sulfuric acid.

The CAA requires the EPA to assign a designation of each region of the U.S. regarding compliance with the NAAQS. The EPA categorizes the level of compliance or noncompliance with each criteria pollutant as follows:

- Attainment – area currently meets the NAAQS
- Maintenance – area currently meets the NAAQS, but has previously been out of compliance
- Nonattainment – area currently does not meet the NAAQS

Ozone nonattainment areas are further classified as extreme, severe, serious, moderate, or marginal depending on the severity of nonattainment.

The TCEQ has the responsibility for developing a plan for maintaining or attaining the NAAQS. This plan, which was submitted to and approved by the EPA, is called the State Implementation Plan (SIP). Similarly, the LDEQ has the responsibility for developing the SIP for Louisiana. For areas that are in nonattainment with the NAAQS, the SIP describes how the area would reach attainment of the air quality standards. The SIP sets emissions budgets for point sources such as power plants and manufacturers, areawide sources such as dry cleaners and paint shops, off-road mobile sources such as boats and lawn mowers, and on-road sources such as cars, trucks, and motorcycles.

As previously noted, the project study area includes Jefferson and Orange counties. These counties are within an area designated as the Beaumont-Port Arthur (BPA) Air Quality Control Region (AQCR). Ozone is the only criteria pollutant from which the BPA fails to meet the NAAQS. The EPA has classified the BPA area as a “serious” nonattainment area under the 1-hour NAAQS for ozone and a “moderate” nonattainment area with regard to the 8-hour NAAQS for ozone. Under the current attainment classification, the BPA has until June 15, 2010, to attain the 8-hour NAAQS for ozone. However, 8-hour ozone data for 2005, 2006, and 2007 indicate that the BPA area is monitoring attainment of the standard. As a result, the TCEQ adopted a SIP revision that includes a Redesignation Request and a Maintenance Plan for the BPA area (TCEQ, 2008). This maintenance plan is currently pending review by the EPA.

Calcasieu Parish is in the Lake Charles AQCR and Cameron Parish is in the southern Louisiana-southeast Texas AQCR. These parishes are currently classified as being in attainment with the NAAQS for all criteria pollutants.

3.7.2 Conformity of Federal Actions

As required by the CAA, the EPA has also promulgated rules to ensure that Federal actions conform to the appropriate SIP. Two rules were promulgated: (1) the Transportation Conformity Rule (40 CFR Part 93); and (2) the General Conformity Rule (40 CFR Part 51, Subpart W). The Transportation Conformity Rule applies to the Federal Highway Administration (FHWA)/Federal Transit Authority projects within maintenance or nonattainment areas. The General Conformity Rule applies to Federal actions, except FHWA and Transit Authority actions, within maintenance or nonattainment areas.

The CAA prohibits Federal agencies from funding, permitting, or licensing any project that does not conform to an applicable SIP. The purpose of this General Conformity requirement is to help ensure that Federal agencies consult with State and local air quality districts to assure these regulatory entities know about the expected impacts of the Federal action and have considered or will include expected emissions in their SIP emissions budget.

The General Conformity Rule provides for emission thresholds above which a General Conformity Determination would be required. For the BPA ozone nonattainment area, which is classified as ”moderate” under the 8-hour ozone standard, the emissions threshold is 100 tons per year (tpy) of NO_x or of VOC. Therefore, if the total emissions from the project are estimated to be equal to or greater than this threshold for NO_x or VOC, the USACE must prepare a General Conformity Determination showing how the project conforms or would conform with the SIP for that pollutant, prior to undertaking the action. Even if emissions of NO_x or VOCs are below these levels, a conformity determination would also be required if the increase in emissions due to the project would equal or exceed 10 percent of the total emissions of those pollutants for the entire nonattainment area (i.e., the project is considered a regionally significant action). The General Conformity Determination was submitted to the TCEQ and the EPA for review concurrently with the DEIS. The TCEQ has provided written concurrence that project emissions are consistent with the most currently approved SIP emissions budgets for the BPA nonattainment area. As Cameron Parish and the Lake Charles area are in attainment with the NAAQS, a general conformity determination would not be required for these areas.

3.7.3 Air Quality Baseline Condition

Table 3.7-2 is a summary of emissions for the BPA and Cameron/Calcasieu parishes based on the currently available air emissions inventory information provided by the EPA. The emissions information for each pollutant is broken out by category: area source, highway, off-highway, and point source emissions based on emissions inventory information for 2002. Although this emissions inventory is not current, it contains the most recent data available, and it provides a base from which to compare the proposed project emissions.

Air pollutants within and near the project area are measured by numerous air monitoring stations. Most of the stations in the region measure the concentrations of criteria air pollutants, as well as temperature, wind velocity, wind direction, and other meteorological parameters. The monitors operate continuously and are routinely calibrated and maintained to assure quality data. Monitoring data (2004 through 2008) for counties in the BPA nonattainment area and for Cameron and Calcasieu parishes are presented in Table 3.7-3 to provide an indication of monitored pollutant concentrations relative to the NAAQS.

As previously noted, the BPA area is classified as a “serious” nonattainment area under the 1-hour NAAQS for ozone and a “marginal” nonattainment with the 8-hour NAAQS for ozone. According to the TCEQ, 8-hour and 1-hour ozone design value trends for the BPA ozone nonattainment area from 1991 to 2007 show decreases in both the 8-hour and 1-hour ozone design values. The design values are used in the evaluation of attainment with the ozone standards. The 8-hour ozone design value has decreased by 17.8 percent over the past 17 years, and the 1-hour ozone design value has decreased by 28.7 percent over the past 17 years. The decreases in ozone have occurred despite increases in population in the BPA area. Eight-hour ozone monitoring data for 2005, 2006, and 2007 indicate that the BPA area is monitoring in attainment of the standard. Monitoring data for Calcasieu Parish (Lake Charles Area) also indicate levels above the 8-hour standard.

3.8 NOISE

3.8.1 Fundamentals and Terminology

Noise is defined as unwanted sound that disrupts or interferes with normal activities, or that diminishes the quality of the environment. Noise is usually caused by human activity and is added to the natural, or ambient, acoustic setting of an area. Exposure to high levels of noise over an extended period can cause health hazards such as hearing loss; however, the most common human response to environmental noise is annoyance. Individuals respond to similar noise events differently based upon various factors that may

Table 3.7-2
Summary of Air Emission Inventory for the Beaumont-Port Arthur Area
and Cameron/Calcasieu Parishes, 2002

	Source Category	CO (tpy)	NO_X (tpy)	PM_{10} (tpy)	$PM_{2.5}$ (tpy)	SO_2 (tpy)	VOC (tpy)
Hardin County	Area	5,758	745	13,796	1,999	109	2,264
	Highway Vehicles	9,401	1,233	31	22	58	719
	Off-Highway	1,879	623	29	27	43	191
	Point Source	296	396	141	86	1	436
SUBTOTAL		**17,334**	**2,997**	**13,997**	**2,134**	**211**	**3,610**
Jefferson County	Area	6,713	1,868	13,834	2,028	1,610	11,506
	Highway Vehicles	43,370	8,246	186	136	304	3,469
	Off-Highway	24,459	32,690	1,804	1,663	6,044	3,330
	Point Source	8,196	24,217	1,669	1,338	27,043	10,864
SUBTOTAL		**82,738**	**67,021**	**17,493**	**5,164**	**35,001**	**29,169**
Orange County	Area	1,357	723	17,745	2,022	572	1,573
	Highway Vehicles	19,588	3,347	76	55	126	1,465
	Off-Highway	5,667	1,423	89	83	201	737
	Point Source	8,270	10,731	1,303	1,160	3,855	3,360
SUBTOTAL		**34,882**	**16,224**	**19,213**	**3,320**	**4,754**	**7,134**
TOTAL – BPA		**134,953**	**86,242**	**50,702**	**10,618**	**39,966**	**39,913**
Cameron Parish	Area (1996)	7,571	154	2,019	834	133	2,121
	Highway Vehicles	2,415	286	9	6	11	204
	Off-Highway	8,858	5,543	455	420	2,854	3,184
	Point Source	2,076	3,119	111	93	32	2,268
SUBTOTAL		**20,920**	**9,102**	**2,594**	**1,354**	**3,030**	**7,777**
Calcasieu Parish	Area (1996)	4,167	1,475	5,470	971	115	11,311
	Highway Vehicles	42,091	5,802	159	118	198	3,425
	Off-Highway	17,033	16,962	629	616	1,389	2,243
	Point Source	10,805	34,924	4,246	3,261	53,664	9,797
SUBTOTAL		**74,096**	**59,163**	**10,504**	**4,966**	**55,366**	**26,776**
TOTAL CAMERON/CALCASIEU		**95,016**	**68,265**	**13,098**	**6,319**	**58,397**	**34,553**
TOTAL BPA/CAMERON/CALCASIEU		**229,969**	**154,507**	**63,800**	**16,937**	**98,363**	**74,467**

Source: EPA (2002a).

Table 3.7-3
Monitored Values[1] Compared with NAAQS, Beaumont-Port Arthur and Cameron/Calcasieu Parishes[2], 2004–2008[3]

County/ Parish	Year	24-hour Value for $PM_{2.5}$ ($\mu g/m^3$)	Annual Mean Value for $PM_{2.5}$ ($\mu g/m^3$)	1-hour Value for O_3 (ppm)	8-hour Value for O_3 (ppm)	24-hour value for SO_2 (ppm)	Annual Mean Value for SO_2 (ppm)	1-hour Value for CO (ppm)	8-hour Value for CO (ppm)	Annual Mean Value for NO_2 (ppm)	Quarterly Mean Value for Pb ($\mu g/m^3$)
Hardin	--	--	--	--		--	--	--	--	--	--
Jefferson	2004	26.8	11.57	0.132	0.091	0.068	0.004	--	--	0.010	--
	2005	36.4	15.00	0.129	0.083	0.029	0.004	3.1	1.4	0.009	--
	2006	26.7	11.14	0.114	0.085	0.050	0.004	1.3	0.9	0.0009	--
	2007	26.7	11.60	0.124	0.082	0.030	0.003	1.9	0.7	0.009	--
	2008	32.6	10.41	0.110	0.078	0.034	0.003	1.8	1.0	0.008	--
Orange	2004	29.3	12.17	0.100	0.078	--	--	--	--	0.007	--
	2005	34.8	12.52	0.103	0.078	--	--	--	--	0.007	--
	2006	28.8	11.31	0.103	0.078	--	--	--	--	0.008	--
	2007	28.6	10.49	0.110	0.075	--	--	--	--	0.006	--
	2008	25.3	9.11	0.107	0.069	--	--	--	--	0.006	--
Cameron	--	--	--	--		--	--	--	--	--	--
Calcasieu	2004	29.5	10.39	0.118	0.082	0.020	0.003	--	--	0.007	--
	2005	27.4	12.14	0.117	0.085	0.016	0.003	--	--	0.008	--
	2006	28.4	11.51	0.125	0.080	0.010	0.002	--	--	0.009	--
	2007	23.7	9.58	0.103	0.078	0.013	0.003	--	--	0.007	--
	2008	20.9	9.32	0.101	0.073	0.010	0.003	--	--	0.007	--
	NAAQS	35	15.0	0.12	0.075	0.14	0.03	35	9	0.053	1.5

Source: EPA (2002b).

-- Not available.

[1] Selection of monitored values is based on criteria established in 40 CFR, Part 50. Parameters and data reported here represent those available in EPA's Aerometric Information Retrieval Database (AIRData): "AIRData-Monitor Values Report" as of September 2009.

[2] Data for Hardin County and Cameron Parish were not available in EPA Air Data Report.

[3] 2004–2008 available data to date.

include the existing background level, noise character, level fluctuation, time of day, the perceived importance of the noise, the appropriateness of the setting, and the sensitivity of the individual.

Sounds of the same pressure but different frequencies are not perceived by the human ear as equally loud. The human ear is less sensitive to low frequencies and extremely high frequencies, and most sensitive to the mid-range frequencies that correspond with human speech. Therefore, in order to measure sound in a manner similar to human perception, an adjustment known as "A-weighting" is used. All regulatory agencies require that measurements be taken using the A-weighted sound level (dBA).

Although A-weighted sound measurements indicate the level of environmental noise at any given time, community noise levels vary constantly. Typical noise environments consist of numerous noise sources that vary and fluctuate over time. Because of the varying noise levels within a community, it is necessary to use a descriptor called the equivalent sound level (L_{eq}). L_{eq} provides a way to describe the average sound level, in decibels (dB), for any time period under consideration.

Another measurement descriptor of the total noise environment is the Day-Night Sound Level (L_{dn}), which is the A-weighted equivalent sound level for a 24-hour period with an additional 10 dB weighting imposed on the equivalent sound levels occurring during nighttime hours (10:00 P.M. to 7:00 A.M.). For example, an environment that has a measured daytime equivalent sound level of 60 dBA and a measured nighttime sound level of 50 dBA, would have a weighted nighttime sound level of 60 dBA (50 + 10), and an L_{dn} of 60 dBA. Numerous Federal agencies including the EPA, Department of Defense, Department of Housing and Urban Development, and Department of Transportation/Federal Aviation Administration (FAA) have adopted this descriptor in assessing environmental impacts. Regulatory agencies generally recognize an L_{dn} of 55 dBA as a goal for the outdoor noise environment in residential areas. Studies have found that outdoor noise environments across the U.S. range from approximately 40 L_{dn} in rural residential areas, to nearly 60 L_{dn} in older urban residential areas, to as much as 90 L_{dn} in congested urban settings (EPA, 1974).

3.8.2 Affected Environment

Noise-sensitive receptors are facilities or areas where excessive noise may disrupt normal activity, cause annoyance, or loss of business. Land uses such as residential, religious, educational, recreational, and medical facilities are more sensitive to increased noise levels than are commercial and industrial land uses. Noise-sensitive receptors in the vicinity of the study area are located in the cities of Port Arthur, Port Neches, and Beaumont. The existing noise environment of these communities is affected by a number of sources, most of which are transportation related (i.e., barges, roadway, railway, etc.). Waterborne transportation activities that currently contribute to the region's ambient noise environment include barges, commercial fishing/shrimping vessels, sport and recreation boats, and current maintenance dredging of the canal. Other sources that contribute to the existing noise environment of these communities include activities at nearby commercial enterprises, such as restaurants, marinas, activities at commercial fishing and shrimping businesses, and numerous heavy industrial uses. Ambient noise levels measured in other Texas coastal communities with a similar degree of activity generally ranged between 60.9 and 65.1 L_{dn} (HFP Acoustical Consultants, Inc., 2002).

3.9 VEGETATION

3.9.1 Introduction

The study area is located within the Gulf Coast Prairies and Marshes and Pinewoods Vegetation Areas (Hatch et al., 1990). A generalized map of the vegetation and land cover types appears on Figure 3.9-1. Maps of each hydro-unit are provided in Appendix C. The vegetation communities include saline to fresh marshes, swamps, bottomland hardwood forests, upland grasslands, and forests. The study area includes an important ecosystem called the Chenier Plain (aka strandplain). Chenier is derived from a French word that means “a place where oaks grow.” Cheniers are paleo-beach ridges that parallel the shoreline (USFWS, 1998; White et al., 1987) fanning out (diverging) where they are cut by river mouths. This “fanning out” pattern occurs near Sabine Pass. The ridges are topographically higher than the surrounding area because they are composed of coarse-grained material (sand and shell) that is more resistant to erosion. The formation and maintenance of the cheniers depends on the input of sand deposited by rivers, transported by westerly longshore currents, and reworked by storms. The upland habitat of the cheniers supports the Coastal Live Oak-Sugarberry Series (*Quercus virginiana-Celtis laevigata*), a maritime woodland or forest (woodlots/oak mottes) of the Upper Gulf Coast that is unique to the Chenier Plain and should be considered sensitive habitat (USFWS, 1998). The modern Chenier Plain system occurs in Louisiana and Texas where the linear ridges and swales are evident in topography and vegetation communities. Transitional and upland vegetation communities occur on the ridges, and wetland communities occur in the interridge swales. The Chenier Plain is separated from the Pleistocene Prairie Complex to the north by a broad low area, which is dominated by brackish marshes (LCWCR/WCRA, 1998).

A band of saline and brackish marshes parallels the coast immediately landward at the beach/dune complex and shore areas. This area is widest in the Mississippi delta and narrows to the west. This east-to-west narrowing is evident in the study area. The wetland communities extend up river, bayou, and creek floodplains, becoming increasingly fresh upstream. The forested wetlands occur in the fresher areas of these floodplains and are primarily cypress-tupelo swamps. These swamps occur along with bottomland hardwood forests and other wetlands within the floodplains. Uplands predominate in the north (especially the northwestern) part of the study area and include grassland and forests. Most of the nonforested upland has been converted to agricultural land. The upland forest is predominantly a pine-oak mix forest (USFWS, 1998; White et al., 1987). Chinese tallow, an exotic, invasive species that has been a management problem since the 1970s, occurs in both upland and bottomland areas, especially in disturbed areas such as fallow croplands.

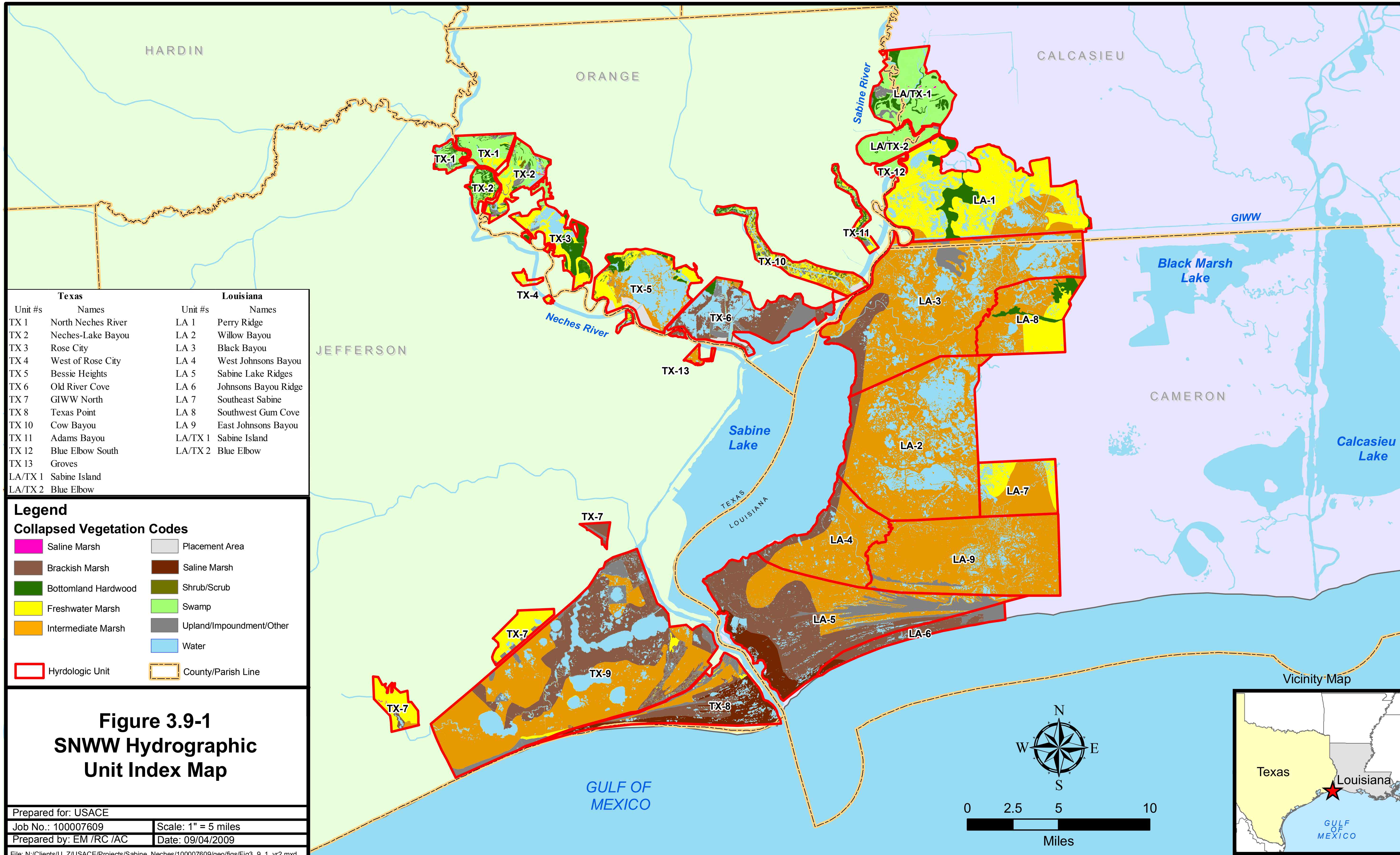


Figure 3.9-1
SNWW Hydrographic Unit Index Map

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3.9.2 Protected and Sensitive Habitats in the Study Area

The term "sensitive habitat" should not be confused with the term "critical habitat." Critical habitat is a legal term with respect to the Endangered Species Act (ESA) and refers to a specific geographic area identified by the USFWS for a federally protected species (see Section 3.12). Sensitive habitat is a subjective term, not a legal term, and generally refers to the vulnerability of a habitat. Spatial extent, uniqueness, endemic quality, or vulnerability to ongoing pressures or imminent changes may make a habitat environmentally sensitive (e.g., large historical losses as with the coastal prairie or fresh marsh losses due to saltwater intrusions). For various reasons the following habitats that occur in the study area should be considered sensitive.

The study area contains a high concentration of significant coastal wetlands. The ICT identified 109,175 acres (171 square miles) in Texas and 197,530 acres (309 square miles) in Louisiana of coastal marsh, bottomland hardwood, and cypress-tupelo swamp habitats, which are addressed in the impact evaluation and described in detail in the following subsections.

3.9.2.1 Texas Portion of the Study Area

In Texas, beginning at the coast and working inland, the following protected and sensitive habitat areas are present within the study area:

- Approximately 10,000 acres of fresh to salt marsh in the Chenier Plain west of Sabine Pass, the majority of which consists of the Texas Point NWR. This NWR is part of the Texas Chenier Plain NWR complex (USFWS, 2005a). This area is indicated as hydro-unit (HU) TX 8 on Figure 3.9-1.
- 55,700 acres of fresh to salt marsh located west of the Sabine River between Texas Point and the mouth of the Neches River (TX 7 and 9). Much of this area is protected by the J.D. Murphree WMA and the McFaddin NWR. Managed by the TPWD, the J.D. Murphree WMA totals 24,250 acres of fresh, intermediate, and brackish water wetlands in the Texas Chenier Plain (TPWD, 2005a). It is located just inland of the Texas Point WMA and extends north of the GIWW. The eastern half (approximately 23,000 acres) of the McFaddin NWR is also part of the study area. This NWR is also part of the Texas Chenier Plain NWR complex. The McFaddin NWR protects one of the largest remaining freshwater marshes on the Texas coast and thousands of acres of intermediate to brackish marsh (USFWS, 2005a). It is located adjacent to and just west of Texas Point WMA.
- 22,100 acres of fresh, intermediate, and brackish marshes and 2,850 acres of cypress-tupelo swamp and bottomland hardwoods on the Neches River from the mouth of the river where it empties into Sabine Lake to the City of Beaumont (TX 3 through 6). Approximately 9,580 of these acres consist of open-water areas resulting from breaking and eroding marsh in the marshes at Rose City, Bessie Heights, and Old River Cove. The Nelda Stark Unit and Old River units of the Lower Neches River WMA (TPWD, 2005b) are located in this area.
- 6,490 acres of Neches River cypress-tupelo swamp and bottomland hardwoods and 1,970 acres of fresh marsh between the City of Beaumont and the new Neches River Saltwater Barrier near Pine Island Bayou (TX 1 and 2). A USACE-approved, privately operated, wetlands mitigation bank (the Neches River Cypress Swamp Preserve) is located within this area (USACE, 2005a).

- 4,771 acres of cypress-tupelo swamps, bottomland hardwood, and fresh and intermediate marshes on Cow and Adams bayous (TX 10 and 11). The Adams Bayou Unit of the Lower Neches River WMA (TPWD, 2005b) is located in this area.
- 689 acres of cypress-tupelo swamp west of the Sabine River and south of IH 10 (TX 12).
- 2,737 acres of cypress-tupelo swamp and bottomland hardwoods in the Blue Elbow Swamp (LA/TX 2). Located north of IH 10 and west of the Sabine River, this area is owned by TxDOT and managed as the USACE-approved Blue Elbow Mitigation Bank (USACE, 2005b). The area includes the Tony Houseman WMA, managed as a cooperative effort between the TxDOT and TPWD (TPWD, 2005c).
- 2,277 acres of cypress-tupelo swamp and bottomland hardwoods west of the Sabine River, across from the Sabine Island WMA in Louisiana (LA/TX 1).
- 6,000 acres of cypress-tupelo swamp, bottomland hardwood forest, and freshwater marsh below the Saltwater Barrier, on Big Thicket National Preservelands in Texas (TX1 and 2).

3.9.2.2 Louisiana Portion of the Study Area

In Louisiana, beginning at the coast and working inland, the following protected and sensitive habitat areas are present within the study area (LCWCR/WCRA, 1998; USGS-NWRC, 2004):

- 71,470 acres of saline, brackish and intermediate marshes in the Louisiana Chenier Plain habitat at Louisiana Point, Blue Buck Point, and Johnson's Bayou areas (LA 4, 5, 6, and 9). Sensitive areas include Sabine Lake Ridges (33,472 acres of chenier ridge, and saline, brackish, and intermediate marsh), Johnson's Bayou Ridge (4,089 acres of saline and brackish marshes, and chenier ridges), West Johnson's Bayou (13,190 acres of brackish and intermediate marsh), and East Johnson's Bayou (26,719 acres of chenier ridge, and fresh, intermediate, and brackish marsh).
- 44,325 acres of brackish, intermediate, and fresh coastal marsh in the western half of the Sabine NWR (LA 3 and 7). The Sabine NWR, as a whole, contains 124,511 acres of fresh, intermediate, and brackish marsh between Calcasieu and Sabine lakes in southwest Louisiana (USFWS, 2005b). Approximately 13,744 acres of marsh within this study area has degraded to open water. This sensitive area contains the Willow Bayou mapping unit (36,291 acres) and 8,034 acres in the west section of the Southeast Sabine mapping unit.
- 46,511 acres of brackish, intermediate, and fresh marsh in an area north of Willow Bayou and south of the GIWW (LA 2 and 8). This sensitive area contains the Black Bayou mapping unit (36,291 acres) and 10,220 acres of fresh and intermediate marsh in the Southwest Gum Cove mapping unit.
- 25,721 acres of fresh and intermediate marsh and bottomland hardwood habitat in the Perry Ridge mapping unit, north of the GIWW and east of the Sabine River (LA 1).
- 650 acres of cypress-tupelo swamp and bottomland hardwoods in the Blue Elbow Swamp, east of the Sabine River and north of IH 10 (LA/TX 2).
- 7,039 acres of cypress-tupelo swamp and bottomland hardwoods in the Sabine Island WMA, north of the Blue Elbow Swamp and east of the Sabine River (LA/TX 1).

3.9.3 Historical Changes

The coastal wetlands of the Calcasieu and Sabine river basins were historically an unbroken stand of coastal wetlands including fresh to brackish marshes and swamps (Marcantel, 1996). Most of the brackish marshes bordered Calcasieu and Sabine lakes. In the 1940s and 1950s, this ecosystem began to fragment and exhibit other significant alterations, due in part to the construction of several major navigation channels (Calcasieu Ship Channel, GIWW, SNWW), which increased salinity throughout the estuary, including the lakes and surrounding marshes (Marcantel, 1996). The presence of the GIWW and activities along the GIWW made several changes to previous hydrologic conditions. Levees associated with the GIWW and other channels changed drainage patterns, flooding some areas, and blocking sheet flow across extensive areas of marsh. Several miles of Salt Bayou, north of Shell Lake, were lost. Taylor Bayou was rerouted to join the GIWW. Concrete water control structures were placed on both sides of the canal at Star Lake, at the outfall of Salt Bayou and the GIWW, and at Little Keith Lake Cut on Port Arthur Canal, which eventually became inoperable (Sutherlin, 1997).

Petroleum exploration has also caused hydrologic changes in the area. Four major oil fields were developed in Texas marshes west of Sabine Lake beginning in the mid-1920s: Bessie Heights (Neches River), Rose City (Neches River), Clam Lake (McFaddin NWR), and Shell Lake (Sea Rim State Park). Gum Island (La Belle Ranch) was developed in Louisiana, east of Sabine Lake. Levees, roads, and canals associated with these operations, as well as accelerated subsidence caused by subsurface water and petroleum extraction, have changed hydrology and contributed to the conversion of marshes to open water (Sutherlin, 1997). The extensive construction of channels for navigation, petroleum exploration, hunting, fishing, and trapping throughout the area has increased saltwater intrusion into the interiors of the marshes (Marcantel, 1996).

The Chenier Plain in the area of Calcasieu and Sabine lakes has been identified as one of the two Louisiana coastal zones that has experienced the most severe land loss. More than 25 percent of the marsh was lost between 1933 and 1990 within the Sabine, Calcasieu, and Mermentau basins (LCWCR/WCRA, 1998). According to the LCWCR/WCRA report, a 1994 study by Barras et al. found that the westernmost area of Louisiana lost approximately 15,950 acres (18 percent) of marsh between 1978 and 1990.

Currently, within the State of Louisiana, there are approximately 3,800 square miles of marsh and over 800 square miles of swamp. It is predicted that approximately 600 square miles of marsh and 400 square miles of swamp would be lost by conversion to open water by the year 2050 (LCWCR/WCRA, 1998). The Calcasieu/Sabine Basin had 317,100 acres of marsh and 170 acres of swamp in 1990. Using current restoration levels, there would be a net loss of 38,400 acres by 2050; however, no swamp loss is predicted (LCWCR/WCRA, 1998).

According to Morton and Paine (1990), Sutherlin (1997), and White et al. (1987), the most extensive losses of interior coastal wetlands in Texas have occurred along the Neches River delta where 12,632 acres of marshes have been converted to open water. This is more than 90 percent of the marshes in the lower Neches River delta. Contributing factors include subsidence associated with subsurface petroleum and groundwater extraction, eustatic sea level rise, altered hydrology that caused saltwater intrusion, and decreases in sediment and/or nutrient supply.

The inflow of fresh water, primarily from the Sabine and Neches rivers, buffers the salt water emanating from the Gulf; that is, the salt water coming inland, via the SNWW and other channels, is buffered by discharges of fresh water from reservoirs on the Sabine and Neches rivers. Saltwater coming up the Calcasieu Ship Channel is only buffered by rainfall, so the surrounding marshes of the ship channel and Calcasieu Lake are more vulnerable to saltwater intrusion. There is more-active management to protect wetlands from saltwater intrusion around Calcasieu Lake than Sabine Lake (Marcantel, 1996). See Section 3.5 for further discussion on the hydrology.

Saltwater intrusion and its impact on marshes have been managed, in part, by the use of water control structures. In 1990 there were 174 water control structures identified in the Calcasieu and Sabine River basins (Marcantel, 1996). See Section 3.5 of this FEIS for more information regarding water control structures and other hydrologic alterations.

The construction of the GIWW and activities associated with the SNWW had several effects, some of which are:

- altered habitat associated with Salt Bayou (north of Shell Lake);
- severed Salt Bayou north of Star Lake;
- altered course of Taylor Bayou to join GIWW;
- constructed concrete water control structures on both side of canal at Star Lake, at outfall of Salt Bayou and the GIWW, and at Little Keith Lake Cut on Port Arthur Canal, which eventually became inoperable;
- altered habitat and land loss in the Black Bayou watershed;
- altered habitat and land loss in the Willow Bayou watershed;
- shoreline erosion along the banks of the GIWW; and
- blocked sheet flow across marshes.

Roads and levees also altered hydrologic patterns, particularly in the coastal zone where a small change in topographic relief can significantly alter surface hydrology. Openings and water control structures associated with these features also affect the hydrology. Important features include:

- Louisiana SH 27 along east boundary of the Calcasieu/Sabine River Basin (north to south orientation);
- SH 82 (Calcasieu Ship Channel to Sabine Pass) along south boundary forms barriers along the east and south perimeters;
- Rycade Canal (south of Black Lake);
- Gray's Ditch levee/cattle walkway (north to south, Pines Ridge – Johnson's Bayou) forms a barrier along east bank of Sabine Lake (Marcantel, 1996); and

- SH 87 and SH 73 altered hydrology in Orange and Jefferson counties (Sutherlin, 1997).

Wildlife management units within the river basins use levees and other water control structures to manage areas for specific habitat types (Marcantel, 1996):

- Pool 3A on Sabine NWR is managed as a freshwater marsh.
- Round Lake and Lost Lake in the J.D. Murphree WMA are managed as fresh marsh.

According to Morton (1996), the marshes on the eastern shoreline of Sabine Lake and Sabine Pass have remained essentially natural in contrast to the more developed west side that has been greatly altered by the SNWW and associated ports. Also, most of the western shore of Sabine Lake has been elevated by placement of dredged material, and shorelines have been armored to protect against erosion associated with the predominant southeastern winds.

According to Marcantel (1996), the overall condition of the marshes within the Calcasieu/Sabine River Basin have been improving. This is attributed to above-average rainfall and the stabilization of tidal fluctuations and water salinity. Marcantel (1996) warns that the salinity in Sabine Lake needs to continue to be stabilized to avoid the level of management required in Calcasieu Lake. As discussed in Section 3.5, freshwater inflows from the Sabine and Neches rivers are largely moderated by flood control structures and freshwater impoundments upstream. A freshwater inflow study was prepared to establish the basic requirements of the ecosystems of the floodplains and the estuary (Kuhn and Chen, 2005).

Land loss has occurred at high rates in recent decades (Berman, 2005; Morton, 2003; Morton et al., 2005; Shinkle and Dokka, 2004; Titus and Narayanan, 1995). In Louisiana, a net land loss of 21 percent between 1978 and 2000 has been reported in the Chenier Plain subregion of coastal Louisiana, which includes the Sabine estuary (USACE, 2004a). In Texas, the most extensive losses of interior coastal wetlands in the state (12,632 acres between 1930 and 1978) have occurred in the Neches River delta. In total, over 90 percent of the emergent marshes in the Lower Neches River delta have been converted to open water (Morton and Paine, 1990; White et al., 1987), which is more than half of the total wetland loss in the State of Texas (Sutherlin, 1997).

Underlying causes of coastal land loss can be divided into two general categories, natural and man-induced (Morton, 2003). Natural causes include erosion, sediment reduction, submergence due to relative sea level rise, and wetland deterioration. Induced causes include construction and dredging in the coastal zone, upstream dams, river channelization, changes to overland sheet flow, fluid extraction, and climate alterations. NOAA has documented a trend of mean sea level rise at Sabine Pass of 0.2 inch/year from 1958 through 1999 (USDC-NOAA, 2009). The reader is referred to Appendix C for further discussion of the rates and cause of RSLR and coastal land loss.

3.9.4 Wetland and Aquatic Vegetation Communities

The following paragraphs include general descriptions of the wetland (including aquatic) vegetation communities that occur in the study area. The descriptions include ecological functions, historical trends, and vulnerabilities. Detailed descriptions of the vegetation communities within each hydro-unit are provided in the Ecological Modeling Report (Appendix C, Section 7.0), so to avoid duplication, they are not included here.

Submerged Aquatic Vegetation

SAV provides important food and cover to a wide variety of fish and wildlife. SAV beds are associated with many kinds of marshes from saline to fresh, as well as in open bay waters. Fresh and intermediate marshes, in particular, often support diverse communities of submerged and floating leaved vegetation. Brackish marshes can support aquatic plants that provide food and cover for several species of fish and wildlife. Although amounts are generally less than those that occur in fresh or intermediate marshes, certain species such as widgeon grass, coontail, and milfoil can be abundant under some conditions, and widgeon grass, in particular, is an important food source for waterfowl. Low-salinity saline marshes may contain widgeon grass, which tolerates a wide range of salinities. Open-water areas in saline marshes generally contain sparse aquatic vegetation and are primarily important as nursery areas for marine organisms.

To a large extent, seagrass distribution in Texas parallels the precipitation and inflow gradients along the Texas coast. Seagrasses are common along the middle to lower coast where rainfall is low and evaporation is high. This correlates with average baywater salinities above 20 ppt. Conversely seagrass is scarce in bays of the upper coast where rainfall and inflows are high and salinities are lower (TPWD, 1999). These areas are also more turbid, which also limits sunlight penetration for seagrass growth (TPWD, 1999).

The TPWD (1999) reports that well-known annual species often occur in at least portions of all Texas bays except for Sabine Lake. However, the low-salinity-tolerant species, widgeon grass, technically not a seagrass because it tolerates very low salinity, can be found in protected parts of the Sabine Lake system. In addition, other SAV found in the study area include Eurasian watermilfoil (*Myriophyllum spicatum*) and freshwater eelgrass (*Vallisneria americanum*). Most available data on distributions of SAV for the Texas Gulf Coast are for seagrass meadows of the Laguna Madre (Onuf, 1995; Pulich et al., 1997; Quammen and Onuf, 1993). Few data are available for the upper Texas coast (Adair et al., 1994). Polyhaline species (18 to 30 ppt) found in the study area include widgeon grass; mesohaline species (5 to 18 ppt) include Eurasian watermilfoil, a nonnative invasive species, and freshwater eelgrass.

Baseline values for SAV, used in the EMCM, were based largely upon previous observations by Habitat Workgroup members in the hydro-units that they manage or regulate, and data collected for CWPPRA or other restoration projects in or near the areas under evaluation.

SAV cover and species type can and do change rapidly in response to a complex interaction of many conditions (e.g., salinity, freshwater introduction, nutrient input, turbidity, water depth, fetch).

Marshes and Flats

Coastal marshes include a variety of wetland communities (species assemblages) that are differentiated by salinity, elevation, and soil regimes. Marshes range from saline, brackish, intermediate, to fresh water. Soil saturation is highly correlated with elevation and influences the type of marsh community that an area supports. The terms *Low* and *High* reflect this relationship and may actually reflect only small changes in elevation, but may be significant when compared to the broad, flat areas of the coast. These plant communities, as well as unvegetated flats, commonly form intricate mosaics of the various communities associated with these subtle changes in topography.

Flats may be sparsely vegetated. In general, less than 30 percent vegetative cover will distinguish a flat from a marsh. Tidal flats are periodically flooded by tidal waters. The term flat includes sandbars, mudflats, and other nonvegetated or sparsely vegetated habitats also called salt flats. Sparse vegetation that occurs on salt flats may include glasswort (*Salicornia* spp.), saltwort (*Batis maritima*), and shoregrass (*Monanthochloe littoralis*).

These wetlands serve many ecological functions. Persistent emergent vegetation provides foraging, resting, and breeding habitat for a variety of coastal fish and wildlife species. Detritus from coastal marshes also provides a source of mineral and organic nourishment for organisms at the base of the food chain. Loss of emergent coastal marsh is a serious existing condition in the study area, and it is assumed that this loss would continue due to RSLR (USDC-NOAA, 2009). Existing and potentially accelerated marsh loss associated with channel deepening has been identified as one of the highest concerns by resource agencies and the general public. Mitigation measures should, therefore, maximize emergent marsh creation, maintenance, and protection.

Important features of marshes include the amount of marsh edge (linear distance of open water/vegetation interface) and interspersion that reflects the relative amount of marsh to open water and the degree to which open water is dispersed throughout the marsh. Interspersion is an important characteristic for fresh water and estuarine fish and shellfish nursery and foraging habitat in all marsh types. The marsh/open-water edge provides cover for postlarval and juvenile organisms.

Deeper water is assumed to be less biologically productive than shallow water because sunlight, oxygen, and temperature are reduced as depth increases. Shallow water also provides better bottom access for waterfowl, better foraging habitat for wading birds, and more-favorable conditions for the growth of aquatic vegetation.

Increase in salinity associated with the existing navigation project are one of the most important factors affecting coastal land loss in the study area. As salinity increases, biological productivity in the marsh is reduced thereby increasing vulnerability to land use.

Access by estuarine-dependent fishes and shellfishes, as well as other aquatic organisms, is important in assessing the quality of marsh systems. It is assumed that a high degree of hydrologic connectivity with adjacent systems provides high organism access, as well as providing greater nutrient exchange. Brackish and saline marshes are assumed to be more important than fresh/intermediate marshes as habitat for estuarine-dependent fish and shellfish.

White and Tremblay (1995) summarize many factors that have contributed to marsh loss in the study area. In most cases, marsh loss occurs by conversion of the marshes to open water. In the lower Neches River Valley, this conversion is caused by subsidence and faulting (sometimes related to oil and gas production), dredged canals, alteration of hydrologic regime (due to channelization and placement of dredged material), decreased input of fluvial sediment (due to upstream dams), and construction of artificial levees. Similar factors are responsible for marsh loss in the Sabine River Basin.

Since 2000, there have been large areas of die-off in the low salt marshes on the Gulf Coast, commonly called Brown Marsh phenomenon (LDNR, 2002a). The area most severely impacted is east of the study area, between the Mississippi and Atchafalaya rivers. Although the causes are unknown, it is believed to be a combination of factors, including weather regimes, and is currently under study.

Low marshes for all salinity types are distinguished by the species composition. Indicator species by marsh type appear below (LDNR, 2002b; McKee et al., 2006; USFWS, 1998). More-extensive species lists appear in Visser and Sasser (1998) and White et al. (1987). Additional descriptions of these marsh types appear in Appendix C, Section 7.0.

Saline Marsh

- Smooth cordgrass, oystergrass (*S. alterniflora*) – dominant species in low marsh
- Seashore saltgrass (*Distichlis spicata*)
- Blackrush (*Juncus romerianus*)
- Saline marsh aster (*Symphyotrichum tenuifolius*, syn. *Aster t*.)
- Glasswort – dominant species in high marsh
- Marshhay cordgrass, wiregrass (*S. patens*)
- Sea ox-eye daisy (*Borrichia frutescens*)

Brackish Marsh

- Saltmarsh bulrush (*Scirpus robustus*) – (co-)dominant species in low marsh
- Marsh pea (*Vigna luteola*)
- Waterhemp (*Amaranthus tamariscinus*)
- Seashore saltgrass – (co-)dominant species in high marsh
- Dwarf spikerush (*Eleocharis parvula*)
- Marshhay cordgrass, wiregrass – (co-)dominant species in high marsh

Intermediate Marsh

- Seashore paspalum (*Paspalum vaginatum*) – (co-)dominant species in low marsh
- Olney bulrush (*Schoenoplectus americanus*, syn., *Scirpus a*.) – (co-dominant species in low marsh
- California bulrush, giant bulrush – (co-)dominant species in low marsh
- Common reedgrass, roseau cane (*P. australis*) – (co-)dominant species in low marsh
- Sand spikerush (*E. montevidensis*)
- Marshhay cordgrass, wiregrass – (co-)dominant species in high marsh
- Bulltongue (*Sagittaria lancifolia*)

Freshwater Marsh

- Maidencane (*Panicum hemitomen*) – (co-)dominant species in low marsh
- Giant cutgrass (*Zizaniopsis milacea*) – co-dominant species in low marsh
- Bulltongue – (co-)dominant species in low marsh
- American lotus (*Nelumbo lutea*)
- Watershield (*Brasenia screberi*)
- Duckweed (*Lemna* spp.)
- Fanwort (*Cabomba caroliniana*)
- Squarestem spikerush (*E. quadrangulata*) – co-dominant species in high marsh
- Marshhay cordgrass, wiregrass – co-dominant species in high marsh

In general, the saline marshes are located nearest to the Gulf shoreline. In this area they tend to be linear features, which grade into brackish marshes with increasing distance from the shoreline. Some occur near Sabine Pass in the swales of the Chenier Plain.

Most of the area between the GIWW and the Gulf shoreline is covered with brackish marsh. Most of the marshes on and near the shoreline of Sabine Lake and Sabine Pass are brackish to intermediate, becoming fresher to the north with proximity to the Neches and Sabine rivers. There is generally a gradation from more open-water areas that are saline or brackish to the intermediate marsh areas. These intermediate marshes are encroaching on formerly freshwater areas, but in turn are being encroached upon by brackish waters and marshes.

By altering the natural hydrology, the GIWW and its levees have created a sharper (formerly more gradual) transition from fresh-intermediate water marshes north of the GIWW to brackish-saline marshes on the south side. There are some scattered fresh and intermediate marshes associated with the swales of the Chenier Plain. Some areas with relatively higher elevations support fairly freshwater areas that only seasonally support wetland communities (i.e., "wet prairies"). There are additional freshwater marshes in the riparian zone of the Neches and Sabine rivers. The central part of the Sabine NWR previously supported more freshwater marshes. However, some of this area has been converted to intermediate and brackish marsh due to saltwater intrusion. This intrusion has encroached from the west (Sabine Lake), east (Calcasieu Lake), and south. Some large levied areas within the Sabine NWR (e.g., Pool 3) are being maintained as freshwater impoundments.

Shrub/Scrub Wetlands

These wetlands are generally located adjacent to marshes at somewhat higher elevations. Estuarine intertidal scrub-shrub wetlands are dominated by woody vegetation and periodically flooded by tidal waters. Common species include the black mangrove (*Avicennia germinans*) and big leaf sumpweed (*Iva frutescens*). Sea ox-eye daisy is a woody species that is frequently a co-dominant species in high salt marsh and is described in this report with the marshes.

Freshwater shrub-scrub wetlands are generally associated with riverine systems or in isolated depressional areas (e.g., swales). Common species include buttonbush (*Cephalanthus occidentalis*), rattlebean (*Sesbania* spp.), and alder (*Alnus* spp.).

Swamps (Forested Wetlands)

Two types of swamps or forested wetlands occur in the Chenier Plains of Texas and Louisiana (USFWS, 1998). These occur within the floodplains of waterways, primarily the Neches and Sabine rivers. One of these is a true swamp, which is flooded most or all of the year. It is dominated by bald cypress and tupelo gum trees (*Nyssa* sp.). Many swamp species, especially tupelo gum trees and many herbaceous species, are salinity-sensitive. Bald cypress is able to tolerate higher salinities than the other species. These swamps may occur streamside or in abandoned channels or other depressional areas within the floodplain. Swamps with mature sizable trees are considered to be rare and ecologically important because of the historical loss of swamp habitat from timber harvesting, saltwater intrusion, and a reduced growth rate in the subsiding coastal zone. The hardwoods have been logged repeatedly since the turn of the century (USACE, 1998a), so much of this community is secondary growth.

The other forested wetland is also located within the same floodplains. Common tree species of these bottomland hardwoods include water oak (*Quercus nigra*), red maple (*Acer rubrum*), eastern cottonwood (*Populus deltoides*), box elder (*A. negundo*), Carolina ash (*Fraxinus caroliniana*), overcup oak (*Q. lyrata*), sugar maple (*A. saccharum*), bald cypress, tupelo gum, and swamp privet (*Forestiera acuminata*). These are flooded seasonally at high-water events when the waterways overflow their banks. Some bottomland hardwood areas may not be true and/or CWA Section 404 jurisdictional wetlands, but may be more appropriately considered as dry-riparian communities.

Swamps provide unique habitat to many species. Wildlife foods in swamp habitats consist predominantly of soft mast, other edible seeds, invertebrates, and vegetation. Most swamp tree species produce soft mast or edible seeds. A variety of stand structure (overstory, shrub, herb layer) provides habitat for resting, foraging, breeding, nesting, and nursery activities. The hardwoods, especially the cypress trees, have been logged repeatedly since the turn of the century and as recently as perhaps the 1950s (USACE, 1998a). Though much of the forest is secondary growth, the swamp and bottomland hardwood habitats have medium to high value for food and cover to resident and migratory fish and wildlife.

The hydrology determines the existence and quality of forested wetlands. Seasonal flooding with periodic drying cycles increases nutrient cycling, vertical structure complexity, and recruitment of dominant overstory trees. Seasonal flooding with abundant and consistent riverine/tidal input and water flow-through is considered to be optimal hydrologic characteristic. Optimal conditions for forested wetlands are discussed in the WVA (Appendix C). The WVA model considered several variables (e.g., tree species composition, stand maturity) to assess the overall condition and characterization of the forested wetlands.

Bottomland Hardwood Forests

Bottomland hardwood forests are located in river bottomlands, generally in the floodplain. They are commonly associated with and form mosaics of stands with cypress-tupelo swamps and other forested wetlands (e.g., water oak or ash flats); however, they may not actually be considered wetlands. In the lower Sabine and Neches watersheds, bottomland hardwood forests are found on an intricate network of sandy ridges interspersed with wet sloughs that have formed within the rivers' relict meanderbelts. These are highly productive and diverse ecosystems and serve many ecological functions.

Bottomland hardwood wildlife depends heavily on mast, other edible seeds, and tree buds as primary sources of food. Typical hard mast producers in the study area are oaks, pecan (*Carya illinoinensis*), and other hickories. Soft mast and other edible seeds are produced by red maple, sugarberry (*Celtis laevigata*), green ash (*Fraxinus pennsylvanica*), boxelder (*A. negundo*), common persimmon (*Diospyros virginiana*), sweetgum (*Liquidambar styraciflua*), honeylocust (*Gleditsia triacanthus*), red mulberry (*Morus rubra*), bald cypress, tupelo gum, American elm (*Ulmus americana*), and cedar elm (*U. crassifolia*). Nonmast/inedible seed producers are eastern cottonwood, black willow (*Salix nigra*), and American sycamore (*Platanus occidentalis*).

Mature stands of bottomland hardwood are rare and ecologically important. Historical and ongoing timber harvesting has reduced the number of mature stands and increased the ecological importance of those that remain. These stands provide more hard and soft mast, other edible seeds, and buds than younger stands. They provide important wildlife requisites such as snags, nesting cavities, and medium for invertebrate production.

Upland Grasslands (including Coastal Prairies)

Virtually all (99 percent) of the original Gulf Coastal Prairies (commonly referred to as Cajun Prairies in Louisiana) community has been converted to agricultural, industrial or other uses although some remnants still exist (Smeins et al., 1991). Undeveloped upland grasslands usually have a mix of the original prairie species and introduced pasture species as well as various forbs and occasional shrubs such as honey mesquite (*Prosopis glandulosa*), eastern baccharis (*Baccharis halimifolia*), and southern wax-myrtle (*Myrica cerifera*). Hatch et al. (1990) list common species for Gulf Coast prairie as follows: little bluestem (*Schizachyrium scoparium*), coastal bluestem (*S. scoparium* var. *littoralis*), yellow indiangrass (*Sorgastrum nutans*), eastern gammagrass (*Tripsacum dactyloides*), hairy awn muhly (*Muhlenbergia capillaris*), Texas wintergrass (*Stipa leucotricha*), panicgrasses (*Panicum* spp.), several Paspalum species, broomsedge (*Andropogon virginicus*), smutgrass (*Sporobolus indicus*), threeawn grasses (*Aristida* spp.), yankeeweed (*Eupatorium compositifolium*), western ragweed (*Ambrosia cumanensis*), prickly pear (*Opuntia* spp.), several aster species, Texas paintbrush (*Castilleja indivisa*), poppy mallows (*Callirhoe* spp.), phlox (*Phlox* spp.), bluebonnets (*Lupinus* spp.), and evening primrose (*Oenothera* spp.). Because of the higher rainfall and gradual transition to coastal marshes, the Coastal Prairies in the study area, particularly in Louisiana, switchgrass (*P. virgatum*) is more common than in Coastal Prairies farther west.

The upland grasslands, most of which have been converted to agricultural purposes (crops or pasture), are primarily north of the GIWW, inland of the coastal marshes. Upland grasslands also occur south of the GIWW in Louisiana on the uplands provided by Gum Cove and Perry Ridge (Fearn, 1995) and also in small, scattered patches in the uplands of the chenier complex. Only small, scattered remnants of coastal prairie may be found within the study area.

Upland and Nonwetland Riparian Woodlands and Forests

Several communities of upland forest occur in the study area, including the Coastal Live Oak-Sugarberry Series, Water Oak-Coastal Live Oak series, Loblolly Pine-Oak Series, and Chinese Tallow Woodland. The Coastal Live Oak-Sugarberry Series is essentially a maritime woodland or forest (woodlots/oak mottes) of the Upper Gulf Coast, which is unique to the Chenier Plain (USFWS, 1998). Associated species include yaupon, cedar elm, and ash (*Fraxinus* spp.) intermixed with open patches of little bluestem grasslands (Bezanson, 2001; Harcombe and Neaville, 1977; Texas Natural Heritage Program [TNHP], 1993). The Water Oak-Coastal Live Oak series is a mostly deciduous, riparian woodland of the floodplains and along bayous in the Upper Coastal Prairie, along the Sabine and Neches rivers. Associated species include pecan, cedar elm, sugarberry, yaupon, hawthorns (*Crataegus* spp.), and deciduous holly (*I. decidua*) (TNHP, 1993). The Loblolly Pine-Oak Series may include post, southern red, white, and water oaks (*Q. stellata*, *Q. falcata*, *Q. alba*, and *Q. nigra*). These occur on higher-elevation uplands that generally have acidic soils. This community often occurs as second growth or after disturbance and is highly variable and is a mix of pine and hardwood species (USFWS, 1998). Overstory species include loblolly pine, slash pine (*Pinus elliottii*), water oak, overcup oak, willow (*Salix* spp.), sweetgum, southern magnolia (*Magnolia grandiflora*), American elm, and sugarberry. Understory species include eastern red cedar (*Juniperus virginiana*), blackcherry (*Prunus serotina*), roughleaf dogwood (*Cornus drummondii*), sugarberry, American beautyberry (*Callicarpa americana*), and poison ivy (*Toxicodendron radicans*). These occur in scattered patches in the uplands in the north part of the study area, but also on Perry and Gum Cove ridges. Another woodland type has been created by the introduction of an exotic species, the Chinese tallow tree, which rapidly invades upland and fresh-brackish wetlands in disturbed areas or abandoned agricultural fields. These woodlands are virtual monocultures of tallow trees, but commonly include native species such as sugarberry, American elm, cedar elm, water oak, and ash (Bruce et al., 1995).

Beach/Ridge (includes barrier dune complex)

The current beach communities include a primary and secondary dune complex that is leeward of the unvegetated, beach sands of the shoreline. The primary dunes, located immediately landward of the beach, are taller and offer more protection from wind and hurricane storm surge than the secondary dunes. The secondary dunes, which are landward of the primary dunes, are not as tall and are more densely vegetated. Typical plant species of the primary dunes include sea oats (*Uniola paniculata*), bitter panicum (*P. amarum*), Gulf croton (*Croton punctatus*), beach morning glory (*Ipomea pes-caprae* var. *emarginata*), and fiddleleaf morning glory (*I. stolonifera*). Secondary dune species include marshhay/wiregrass, seashore dropseed (*Sporobolus virginicus*), seashore saltgrass, pennywort (*Hydrocotyle bonariensis*), and partridge pea (*Chamaecrista fasciculata*) (Britton and Morton, 1989; USFWS, 1998). Swales that occur between or within the primary and secondary dune complexes may support brackish-to-intermediate marsh vegetation. The ridge and swale topography of the Chenier Plain represents ancient beach systems. These occur behind the active beach system and exhibit alternating, linear, upland/transitional, and wetland features. The Gulf beach in the study area is heavily eroded and virtually nonexistent in places (e.g., Texas Point) where saline marshes can occur on the coastline.

3.9.5 Preparation of Baseline Data Set to Support the WVA Model

Since the primary impact expected with the proposed project is salinity intrusion, units used to evaluate impacts were defined to the greatest extent possible on hydrologic characteristics. Sensitive habitats that are hydrologically connected to waterways influenced by the proposed project were divided into hydro-units. Uplands and developed areas were excluded from the analysis. Baseline habitat types within each hydro-unit were then classified as marsh (fresh, intermediate, brackish, or saline), cypress-tupelo swamp, or bottomland hardwood. Habitat classification definitions were derived from Cowardin et al. (1979). Numerous other sources were used to map and characterize the wetlands. These are described in detail in Appendix C of this FEIS.

Baseline habitats for the Texas hydro-units were classified and mapped with the assistance of the Habitat Workgroup. The TPWD provided habitat mapping for the Keith Lake/Salt Bayou hydro-unit, the Lower Neches WMA (TPWD, 1992), and Cow Bayou (TPWD, 2004). The USFWS (2001) provided habitat maps of the McFaddin NWR and also mapped habitat types on the Neches River using the National Wetlands Inventory (NWI) data (USFWS and GLO, 1992), supplemented and revised as necessary on the basis of expert knowledge and field visits. All other Texas hydro-units were mapped by PBS&J using collapsed NWI data, reviewed and revised as necessary by the Habitat Workgroup.

Hydro-units and habitat types for Louisiana marsh habitats were drawn directly from mapping units developed for the Louisiana CWPPRA program (Chabreck and Linscombe, 1978; Linscombe, 2001; USGS-NWRC, 2004). Nonmarsh habitats on the Sabine River were mapped by PBS&J using NWI data, reviewed and revised by the Habitat Workgroup.

The existing vegetation and conditions, including detailed descriptions and maps for each hydro-unit, may be found in Appendix C (Section 7), so to avoid duplication, they are not included here.

3.10 AQUATIC ECOLOGY

3.10.1 Freshwater

The study area consists of both freshwater and marine ecosystems. The Sabine and Neches rivers and their tributaries were dominated by fresh water prior to the late 1800s, before Sabine Lake was opened for navigation. It is likely that Sabine Lake was almost entirely fresh, with the exception of saltwater intrusions that emanated from tidal surges during storms or during severe droughts (see Section 3.5 for additional discussions on hydrology). Thus, the biological communities have changed significantly within the past century due to the encroachment of salt water. Most of the tributaries adjacent to Sabine Lake are also influenced by salt water to some extent. Many of the deep navigational channels maintain predominant saltwater wedges that underlie freshwater inflows into the estuary. As a result of this, freshwater species adapted to stenohaline environments may be typically restricted to the upper reaches of the tributaries or occur above (on top of) the saltwater wedge. With high freshwater inflows, Sabine Lake and its tributaries often flush most of the salt water from the estuary resulting in a temporary expansion of freshwater habitat. However, with a return of normal freshwater inflows and tidal currents, Sabine Lake returns to a euryhaline (wide range of salinity) system.

Freshwater fauna typically occur in the tributaries of Sabine Lake including the Sabine and Neches rivers, Taylor, Cow, Adams, and Little Cypress bayous in Texas, Black and Johnson's bayous in Louisiana, as well as numerous other smaller tributaries. Rose City Marsh is predominantly a freshwater environment, and portions of Bessie Heights Marsh, distantly removed from the study area, contain low salinity. In addition, freshwater fauna can be found in the multitude of wetlands, oxbows, ponds, canals, and ditches within the study area.

3.10.1.1 Fisheries

Due to the variety of habitats and the typical diversity of southeastern United States streams, the study area has an exceptionally diverse fish community consisting of approximately 56 freshwater and 25 estuarine species (Hubbs, 1982; USACE, 1975b). Fishery surveys conducted by the TPWD on the Sabine and Neches rivers (TPWD, 1980, 1994) and Taylor, Hildebrand, Cow, Little Cypress, and Adams bayous (TPWD, 1985, 1995a, 1995b) confirm many of these species. Some of these species, including largemouth bass (*Micropterus salmoides*), channel catfish (*Ictalurus punctatus*), crappie (*Pomoxis* spp.), white bass (*Morone chrysops*), and sunfish (*Lepomis* spp.), are important recreational species. Although little information is available regarding angler use, all of these areas are extensively utilized by sport anglers (Driscoll, 2001). There is little to no commercial freshwater fishing on the Texas side of the study area (Young, 2001). Table 3.10-1 lists species collected by the TPWD from Bessie Heights Marsh using gill nets, and from the Neches River using bag seines (Tirpak, 2002). The number of data lines for gill nets represents the number of samples where at least one individual of that species was encountered per mesh size. The TPWD gill nets are 600 feet in length with 150-foot panels each of 3-, 4-, 5-, and 6-inch mesh. For bag seines, the "number of data lines" represents the number of samples where at least one individual of that species was encountered. For each gear type, a higher number of lines indicate a higher encounter rate (not necessarily catch rate) for that species and gear.

The LDWF, Inland Fisheries Division, monitors fish populations with an emphasis on sport fish management on the Sabine River at Niblett's Bluff and within associated bayous downstream of Niblett's Bluff. A variety of freshwater species has been collected from this area including largemouth bass, spotted bass (*M. punctulatus*), bowfin (*Amia calva*), black crappie (*P. nigromaculatus*), spotted sucker (*Minytrema melanops*), golden shiner (*Notemigonus crysoleucas*), sunfish, blue catfish (*I. furcatus*), channel catfish, spotted gar (*Lepisosteus oculatus*), shad (*Dorosoma* spp.), and striped mullet (*Mugil cephalus*) (LDWF, var.). According to the LDWF (pers. comm. District Biologist, 2001), angling along the Sabine River is very popular, including tournament fishing for largemouth bass by local anglers.

3.10.1.2 Macroinvertebrates

Both benthic macroinvertebrates and plankton support the food chain in the freshwater zones. Food chains in the larger, slow-moving rivers, bayous, and backwater areas are similar to those found in lakes. In these systems, the food chain consists primarily of plankton, including microscopic algae (phytoplankton) and crustacea (zooplankton) that are suspended in the water column. Diverse communities of plankton occur throughout the freshwater system, but gradually shift to marine taxa as the water enters the estuarine areas. For the most part, plankton communities found in the study area are ubiquitous and common throughout the southern United States. Phytoplankton communities that occur in the freshwater zones of the study area typically include blue-green algae (Cyanophyta), green algae (Chlorophyta), and diatoms (Bacillariophyta). Zooplankton common to this same area include rotifers (Rotifera), calanoid and cyclopoid copepods (Copepoda), seed shrimp (Ostracoda), and *Daphnia* and *Ceriodpahnia* spp. (Cladocera).

In small streams or streams with higher water velocities, benthic macroinvertebrates are the primary basis of the food chain. Species composition in the rivers, bayous, and streams in the study area is similar to other southeastern United States rivers and streams. General groups of organisms commonly found in these areas include aquatic worms (Oligochaeta), scuds (Amphipoda), crayfish (Cambaridae), mayflies (Ephemeroptera), caddsiflies (Trichoptera), water beetles (Coleoptera), midge flies (Chironomidae), water bugs (Hemiptera), dragonflies (Odanata), and mussels (Bivalvia).

Within the tidally influenced zones, where saltwater wedges or intrusion occur, the macrobenthic community is complex and dynamic (see subsection 3.10.2.1 for additional discussions). Community structure in the shallow margins of these tributaries may consist of those organisms common to freshwater environments due to the partitioning between fresh- and saltwater. However, these freshwater organisms are greatly affected by the encroachment of saltwater wedges. McKee and Wolf (1973) consider dissolved solids between 5,000 and 10,000 mg/L to be beyond the tolerance of most freshwater organisms. Persistent saltwater intrusion with saltwater wedges may allow for the encroachment of estuarine organisms.

Table 3.10-1
Species Collected by TPWD from Bessie Heights (Gill Nets) and Neches River (Bag Seines)
January 1986–June 2001

		Number of Data Lines	
Family Name/Scientific Name	Common Name	Gill Nets Bessie Heights	Bag Seines Neches River
HYDROZOA			
Hydractiniidae			
Podocoryna carnea	Smoothspined snailfur		1
CTENOPHORE			
Beroidae			
Beroe ovata	Sea walnut (comb jelly)		12
Bolinopsidae			
Mnemiopsis mccradyi	Phosphorus jelly		8
MOLLUSKS			
Mactridae			
Rangia cuneata	Atlantic rangia	2	10
CRUSTACEANS			
Penaeidae			
Farfantepenaeus aztecus	Brown shrimp		51
Litopenaeus setiferus	White shrimp		61
Xiphopenaeus kroyeri	Seabob		1
Palaemonidae			
Palaemonetes pugio	Daggerblade grass shrimp		1
Palaemonetes sp.	unidentified grass shrimp		40
Macrobrachium ohione	Ohio shrimp		5
Portunidae			
Callinectes sapidus	Blue crab	95	136
Callinectes similis	Lesser blue crab		8
Xanthidae			
Family mud crabs			2
Grapsidae			
Sesarma reticulatum	Heavy marsh crab		1
Cambariidae			
Procambarus clarkii	Red swamp crawfish		2
BRYOZOANS			
Gymnolaemata			
Zoobotryon verticillatum	Sauerkraut bryozoan	2	

Table 3.10-1, cont'd

Family Name/Scientific Name	Common Name	Number of Data Lines: Gill Nets Bessie Heights	Number of Data Lines: Bag Seines Neches River
FISHES			
Lepisoseidae			
Lepisosteus oculatus	Spotted gar	131	1
Lepisosteus osseus	Longnose gar	6	
Lepisosteus spatula	Alligator gar	117	
Elopidae			
Elops saurus	Ladyfish	10	3
Clupeidae			
Alosa chrysochloris	Skipjack herring	2	
Dorosoma cepedianum	Gizzard shad	145	1
Dorosoma petenense	Threadfin shad		21
Harengula jaguana	Scaled sardine		2
Brevoortia patronus	Gulf menhaden	10	50
Family herrings			3
Engraulidae			
Anchoa hepsetus	Striped anchovy		2
Anchoa mitchilli	Bay anchovy		61
Cyprinidae			
Cyprinus carpio	Common carp	4	
Ictaluridae			
Ameiurus natalis	Yellow bullhead	1	
Ictalurus furcatus	Blue catfish	83	2
Ictalurus punctatus	Channel catfish	3	
Ariidae			
Arius felis	Hardhead catfish	117	18
Bagre marinus	Gafftopsail catfish		1
Belonidae			
Strongylura marina	Atlantic needlefish		7
Cyprinodontidae			
Cyprinodon variegatus	Sheepshead minnow		15
Fundulus grandis	Gulf killifish		13
Lucania parva	Rainwater killifish		1
Poeciliidae			
Poecilia latipinna	Sailfin molly		2
Atherinidae			
Membras martinica	Rough silverside		1
Menidia beryllina	Inland silverside		57

Table 3.10-1, cont'd

Family Name/Scientific Name	Common Name	Number of Data Lines: Gill Nets Bessie Heights	Number of Data Lines: Bag Seines Neches River
Syngnathidae			
Syngnathus scovelli	Gulf pipefish		1
Percichthyidae			
Morone mississippiensis	Yellow bass	20	
Morone saxatilis	Striped bass	2	1
Family Percichthyidae	Family temperate basses	1	
Centrarchidae			
Lepomis macrochirus	Bluegill	3	1
Lepomis microlophus	Redear sunfish	2	
Micropterus salmoides	Largemouth bass	16	1
Carangidae			
Caranx hippos	Crevalle jack		7
Trachinotus carolinus	Florida pompano		3
Chloroscombrus chrysurus	Atlantic bumper		2
Oligoplites saurus	Leatherjacket		11
Gerreidae			
Eucinostomus argenteus	Spotfin mojarra		2
Eucinostomus gula	Silver jenny		8
Sparidae			
Archosargus probatocephalus	Sheepshead	29	1
Lagodon rhomboides	Pinfish	3	8
Sciaenidae			
Aplodinotus grunniens	Freshwater drum	3	
Cynoscion arenarius	Sand seatrout	1	26
Cynoscion nebulosus	Spotted seatrout	72	13
Cynoscion nothus	Silver seatrout		1
Leiostomus xanthurus	Spot	61	32
Micropogonias undulatus	Atlantic croaker	24	122
Pogonias cromis	Black drum	252	
Sciaenops ocellatus	Red drum	345	18
Menticirrhus americanus	Southern kingfish		5
Menticirrhus littoralis	Gulf kingfish		1
Muglidae			
Mugil cephalus	Striped mullet	57	95
Mugil curema	White mullet		14
Polynemidae			
Polydactylus octonemus	Atlantic threadfin		2

Table 3.10-1, cont'd

Family Name/Scientific Name	Common Name	Number of Data Lines	
		Gill Nets Bessie Heights	Bag Seines Neches River
Gobiidae			
Gobionellus boleosoma	Darter goby		6
Gobionellus shufeldti	Freshwater goby		5
Gobiosoma bosc	Naked goby		4
Bothidae			
Citharichthys spilopterus	Bay whiff		23
Etropus crossotus	Fringed flounder		2
Paralichthys lethostigma	Southern flounder	34	29
Soleidae			
Achirus lineatus	Lined sole		1
Trinectes maculatus	Hogchoker		1
Tetraodontidae			
Sphoeroides parvus	Least puffer		3
Synodontidae			
Synodus foetens	Inshore lizardfish		4
Uranocopidae			
Astroscopus y-graecum	Southern stargazer		1
Triglidae			
Prionotus tribulus	Bighead searobin		7
Cynoglossidae			
Symphurus plagiusa	Blackcheek tonguefish		4
MAMMALS			
Myocastoridae			
Myocastor coypus	Nutria	1	

Source: A. Tirpak (2002).

Prior to the implementation of the CWA in the early 1970s, the Neches River, downstream of the saltwater barriers on the Neches River, and Pine Island Bayou were highly impacted by industrial wastewater effluent and saltwater encroachment. Studies by Harrel (1975, 1993), Harrel and Hall (1991), and Harrel et al. (1976) documented the impacts of increased salinity and depressed dissolved oxygen (DO) on benthic macroinvertebrates. The degree of impact was greater downstream in the industrialized portions of the river. Since the implementation of the CWA, water quality has improved with a significant reduction in biochemical oxygen demand (EPA, 1978); however, saltwater intrusion continues to be a problem for freshwater organisms in this area.

3.10.2 Marine

3.10.2.1 Estuarine Habitats and Fauna

3.10.2.1.1 Open-Bay

Sabine Lake, when compared to the other estuarine ecosystems in Texas, covers the smallest surface area (43,978 acres/68.6 square miles) and volume; however, it has the largest surrounding marshland (over 185,000 acres/288.6 square miles) (Armstrong et al., 1987; Blackburn et al., 2001). The average depth of Sabine Lake is 6 feet. Due to the large amount of freshwater inflow into Sabine Lake from stormwater runoff, return flows, and diversions, this estuary has the highest loading of nutrients than any other estuary in Texas (Armstrong et al., 1987). Due to its dynamic salinity (see subsection 3.5.5), Sabine Lake supports a diversity of fish species, plankton, and benthic organisms.

Plankton Assemblages. Phytoplankton (microscopic algae) are the major primary producers (plant life) in the open bay, taking up carbon through photosynthesis and nutrients for growth. Phytoplankton are fed upon by zooplankton (small crustaceans), fish, and benthic consumers. EH&A (1976), found that phytoplankton in Sabine Lake were comprised primarily of both freshwater and marine diatoms (45 percent) and green algae (36 percent). Species composition changed seasonally with minimum abundance occurring in the winter and maximum in the summer. Zooplankton were most abundant during the summer and early fall, coinciding with higher salinities. The dominant species was the copepod *Acartia tonsa* (85 percent), with several other marine copepods also present. Commensurate with higher salinities, the higher numbers were found in the lowest reaches of the estuary. Freshwater species, including rotifers and cladocerans, were the dominant taxa near the mouth of the rivers. Abundance of zooplankton was lowest in the winter and spring and highest in the summer and fall, which is the opposite in other estuaries (with the exception of Galveston Bay) (Armstrong et al., 1987; EH&A, 1976). Marine zooplankton abundance is apparently related to the greater inflow of fresh water into Sabine Lake and Galveston Bay during the winter and spring (Armstrong et al., 1987).

Nekton Assemblages. Nekton assemblages (organisms that swim freely in the water column) consist mainly of secondary consumers, which feed on zooplankton or juvenile and smaller nekton. Sabine Lake supports a diverse nekton population including fish, shrimp, and crabs. Some of these are resident species, spending their entire life in the bay, whereas others are migrant species spending only a portion of their life cycle in the estuary (Armstrong et al., 1987).

Dominant nekton species inhabiting the Sabine Lake estuary are Atlantic croaker (*Micropogonias undulatus*), white shrimp (*Litopenaeus setiferus*), brown shrimp (*Farfantepenaeus aztecus*), Gulf menhaden (*Brevoortia patronus*), bay anchovy (*Anchoa mitchilli*), red drum (*Sciaenops ocellatus*), blue crab (*Callinectes sapidus*), southern flounder (*Paralichthys lethostigma*), black drum (*Pogonias cromis*), striped mullet, sheepshead (*Archosargus probatocephalus*), and spotted seatrout (*Cynoscion nebulosus*), all of which are estuarine dependent (Chambers and Sparks, 1959; Parker, 1965; Reid, 1957). These species are ubiquitous along the Texas and Louisiana coast and are unaffected by changes in salinity. Seasonal differences occur in abundance with the fall usually being the smallest in biomass and number.

Newly spawned fish and shellfish begin migrating into the bay in winter and early spring with the maximum biomass observed during the summer months (Parker, 1965).

Recreational and Commercial Fisheries. Sabine Lake has the second-lowest percentage of the total commercial finfish harvest from all Texas bay systems (Culbertson et al., 2004). Table 3.10-2 lists the TPWD commercial landings for Sabine Lake from 1992 through 2001. From 1992 to 2001, an average of only 1,629 pounds of finfish were commercially harvested in Sabine Lake, with a value averaging $1,540. The amount harvested has declined in recent years. Commercially caught species include Atlantic croaker, black drum, flounder, king whiting (*Menticirrhus americanus*), striped mullet, and sheepshead (Auil-Marshalleck et al., 2001; Culbertson et al., 2004).

The main commercially harvested shellfish species in Sabine Lake are blue crabs (Table 3.10-3). Sabine Lake sustains an important blue crab fishery in Texas and Louisiana. From 1997 through 2001, 27 percent of all blue crabs on the Texas coast were landed from Sabine Lake (Culbertson et al., 2004). From 1990 to 1999, over 1 million pounds of blue crabs were commercially harvested annually from Sabine Lake, with an annual value averaging $843,273 (Culbertson et al., 2004). At one time, white shrimp made up a 330 ton/year fishery. In 1997, this fishery began to decline, possibly as a result of changes in freshwater inflow and concurrent isolation of wetlands from Sabine Lake. This decline was only observed in Sabine Lake while the white shrimp fishery in Galveston Bay and Lake Calcasieu remained the same (Sheridan et al., 1989). Eastern oysters (*Crassostrea virginica*) are not currently commercially harvested from Sabine Lake (see Table 3.10-2); however, they were harvested during 1986 and 1987 (Auil-Marshalleck et al., 2001).

The commercial landings data collected by the LDWF is shown in Table 3.10-3. From 1995 to 2005, an average of 10,375 pounds of finfish were commercially harvested from Sabine Lake, with a value averaging $10,610. These species include alligator gar (*Lepisosteus spatula*) and blue catfish. Shellfish were only harvested in 2001 and 2002, and included 88,362 pounds of blue crab with a value of $76,726 and 908 pounds of white shrimp with a value of $1,223 (Kasprzak, 2007).

Due to the variety of both fresh and saltwater species, recreational fishing is Sabine Lake's largest recreational activity (Davis, 1996). The most sought after species include Atlantic croaker, black drum, gafftopsail catfish (*Bagre marinus*), red drum, sand seatrout (*Cynoscion arenarius*), sheepshead, southern flounder, and spotted seatrout (see subsection 3.10.1.1 for additional discussion on freshwater sport fish). Between May 1982 and May 1992, Sabine Lake (including Sabine Pass) accounted for 10 percent of the annual coastwide recreational fishing landings among bay systems. The majority of these species included Atlantic croaker, southern flounder, black drum, and gafftopsail catfish (Warren et al., 1994). The catch per unit effort in Sabine Lake is 0.35 fish per man-hour of fishing, second only to Galveston Bay. Annual fishing effort is estimated at 500,000 man-hours (Blackburn et al., 2001). The LDWF only collects recreational landings data on a statewide level; there are no data specific to Sabine Lake (Kasprzak, 2007).

Table 3.10-2
Texas Commercial Landings for Sabine Lake
Annual Summaries, 1992–2001

Species	1992 (x 1,000)		1993 (x 1,000)		1994 (x 1,000)		1995 (x 1,000)		1996 (x 1,000)		1997 (x 1,000)		1998 (x 1,000)		1999 (x 1,000)		2000 (x 1,000)		2001 (x 1,000)	
	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$
Fish																				
Atlantic Croaker	0	0	0	0	0	0	0.05	0.02	0.13	0.05	0	0	0.01	0.04	0.11	0.75	--	--	--	--
Black Drum	0.03	0.20	0	0	0.52	0.42	0	0	1.17	0.83	0.70	0.49	0	0	0	0	0	0	0.86	0.60
Flounder	2.03	2.43	0.06	0.06	0	0	0	0	0	0	0.07	0.07	0	0	0	0	0.04	0.09	0	0
King Whiting	7.22	2.02	0.1	0.02	0	0	0	0	0	0	0	0	0	0	0	0	--	--	--	--
Mullet	0	0	0	0	0	0	0.36	0.18	0.41	0.20	0.12	0.3	0.22	0.84	0.08	0.33	1.37	4.16	0.26	1.15
Sand Seatrout	0	0	0	0	0	0	0	0	0	0	0.17	0.09	0.04	0.02	0	0	--	--	--	--
Sheepshead	0.12	0.03	0.04	0.01	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL FISH	**9.40**	**4.68**	**0.20**	**0.09**	**0.52**	**0.42**	**0.41**	**0.20**	**1.71**	**1.08**	**1.06**	**0.95**	**0.27**	**0.90**	**0.19**	**1.08**	**1.41**	**4.25**	**1.12**	**1.75**
Shellfish																				
Blue Crabs	266.31	169.49	871.53	354.64	736.07	387.67	1,278.13	952.96	1,654.86	1,093.93	1,670.86	1,072.53	1,268.24	871.04	1,796.99	1,303.11	1,522.64	1,108.54	1,415.62	1,118.82
Oyster Meats	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Shrimp (Heads On):																				
Brown and Pink	2.89	3.17	5.01	3.85	0	0	0.69	0.94	23.83	16.81	0.92	0.59	0	0	0	0	0	0	0	0
White	19.31	13.89	21.87	15.00	14.92	18.36	9.04	8.52	8.12	8.59	0	0	0	0	0	0	42.21	66.29	0	0
Other	0	0	0.44	0.15	0.91	0.25	0	0	0	0	0	0	0	0	0	0	0	0	0	0
TOTAL SHELLFISH	**288.51**	**186.55**	**898.85**	**373.64**	**751.90**	**406.28**	**1,287.86**	**962.42**	**1,686.81**	**1,119.33**	**1,671.78**	**1,073.12**	**1,268.24**	**871.04**	**1,796.99**	**1,303.11**	**1,564.85**	**1,174.83**	**1,415.62**	**1,118.82**
GRAND TOTAL	**297.91**	**191.23**	**899.05**	**373.73**	**752.42**	**406.70**	**1,288.27**	**962.62**	**1,688.52**	**1,120.41**	**1,672.84**	**1,074.07**	**1,268.51**	**871.94**	**1,797.18**	**1,304.19**	**1,566.26**	**1,179.08**	**1,416.74**	**1,120.57**

Source:
Auil-Marshalleck et al. (2001).
Campbell (2001).
Culbertson et al. (2004).

Table 3.10-3
Louisiana Commercial Landings for Sabine Lake
Annual Summaries, 1999–2005

Species	Year													
	1999		2000		2001		2002		2003		2004		2005	
	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$
Fish														
Alligator gar	21,439.35	19,420.65	16,407.65	17,375.45	10,340.75	10,062.80	3,812.16	4,889.00	0	0	6,522.46	8,097.35	2,900.49	3,256.65
Blue catfish	0	0	0	0	825.36	556.20	0	0	0	0	0	0	0	0
TOTAL FISH	**21,439.35**	**19,420.65**	**16,407.65**	**17,375.45**	**11,166.11**	**10,619.00**	**3,812.16**	**4,889.00**	**0.00**	**0.00**	**6,522.46**	**8,097.35**	**2,900.49**	**3,256.65**
Shellfish														
Blue Crabs	0	0	0	0	88,362.30	76,726.45	0	0	0	0	0	0	0	0
White shrimp	0	0	0	0	0	0	908.00	1,022.70	0	0	0	0	0	0
TOTAL SHELLFISH	**0**	**0**	**0**	**0**	**88,362.30**	**76,726.45**	**908.00**	**1,022.70**	**0**	**0**	**0**	**0**	**0**	**0**
GRAND TOTAL	**21,439.35**	**19,420.65**	**16,407.65**	**17,375.45**	**99,528.41**	**87,345.45**	**4,720.16**	**5,911.70**	**0.00**	**0.00**	**6,522.46**	**8,097.35**	**2,900.49**	**3,256.65**

Source: Kasprzak (2007).

Offshore fishing is also popular in the study area. The main recreational species are king mackerel (*Scomberomorus cavalla*), red snapper (*Lutjanus campechanus*), and sand seatrout. From May 1982 to May 1992, offshore recreational fishing in this area accounted for 4 to 7 percent of the annual coastwide private-boat fishing landings (Warren et al., 1994). The main commercially landed species include flounder, mullet, snapper, and blue crab (Table 3.10-4) (Culbertson et al., 2004). From 1997 to 2001, Sabine Lake represented less than 1 percent of the total annual coastwide finfish commercial landings (Culbertson et al., 2004).

3.10.2.1.2 Open-Bay Bottom

The open-bay bottom includes all areas of Sabine Lake not covered with oyster reefs (Lester and Gonzales, 2001) but does not include the bottoms of ship channels because they are so frequently disturbed by ship passage and maintenance dredging that they never establish a population even approaching a climax community. Benthic organisms are divided into two groups: epifauna, such as crabs and smaller crustaceans, which live on the surface of the bottom substrate, and infauna, such as mollusks and polychaetes that burrow into the bottom substrate (Green et al., 1992). Mollusks and other infaunal organisms are filter feeders that strain suspended particles from the water column. Others, such as polychaetes, feed by ingesting sediments and extracting nutrients. Many of the epifauna and infauna feed on plankton, and are then fed upon by numerous fish and birds (Armstrong et al., 1987; Lester and Gonzales, 2001). The open-bay bottom includes flat areas consisting of mud and sand that contribute large quantities of nutrients and food, making them one of the most important components of this habitat type. EH&A (1976) found that the dominant infauna organism throughout Sabine Lake was the clam (*Rangia cuneata*) and a polychaete of the family Capitellidae. *R. cuneata* was most abundant in areas of lower salinity, whereas polychaetes increased in abundance in areas of higher salinity (EH&A, 1976). Vittor & Associates (1997) found the dominant benthic taxa of Sabine Lake were the polychaetes, *Paraprionospio pinnata* (29.0 percent) and *Mediomastus* sp. (7.7 percent), the oligochaete, *Tubificoides heterochaetus* (23.2 percent), and the bivalve, *R. cuneata* (5.2 percent).

3.10.2.1.3 Oyster Reef

Eastern oyster reefs are present in several areas of Sabine Lake, Sabine Pass, and Keith Lake, and provide ecologically important functions. Oyster reefs are formed where a hard substrate and adequate currents are plentiful. Currents carry nutrients to the oysters and take away sediment and waste filtered by the oyster. Most oyster reefs are subtidal or intertidal and found near passes and cuts, and along the edges of marshes. Oysters can filter water 1,500 times the volume of their body per hour which, in turn, influences water clarity and phytoplankton abundance (Powel et al., 1992; Lester and Gonzalez, 2001). Due to their lack of mobility and their tendency to bioaccumulate pollutants, oysters are an important indicator species for determining contamination in the bay (Lester and Gonzalez, 2001).

Table 3.10-4
Texas Commercial Offshore Landings
Annual Summaries, 1992–2001

Species	Year																			
	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001	
	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$	lbs.	$
	(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)		(x 1,000)	
Fish																				
Black Drum	0.19	0.08	0.09	0.03	0.02	0.01	0	0	0	0	0	0	0	0	0.07	0.05	0.33	0.14	0.008	0.003
Flounder	4.33	4.36	1.61	1.37	1.48	1.49	2.61	2.26	0.83	0.79	0.34	0.38	0.53	0.64	52	0.64	0.45	0.63	0.22	0.33
Sheepshead	0.21	0.10	0.14	0.04	0.02	0.01	0	0	0	0	0	0	0	0	0.01	0.002	0.26	0.08	0.09	0.04
Mullet	5.15	1.45	3.3	0.93	0.1	0.05	0.17	0.08	0	0	0.25	0.13	0.05	0.03	0.46	0.23	0	0	0.02	0.012
Cobia	0.18	0.19	0	0	0	0	0.13	0.16	0	0	0	0	0	0	0	0	0	0	0	0
Grouper	0.20	0.31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Snapper	45.50	80.79	44.25	76.39	26.65	47.53	4.66	9.23	10.49	17.11	9.91	20.26	0.05	0.09	0.39	0.81	0.30	0.73	0.08	0.16
TOTAL FISH	**55.76**	**87.28**	**49.39**	**78.76**	**28.27**	**49.09**	**7.57**	**11.73**	**11.32**	**17.90**	**10.50**	**20.77**	**0.63**	**0.76**	**52.93**	**1.73**	**1.34**	**1.58**	**0.41**	**0.55**
Shellfish																				
Blue Crabs	7.26	3.83	2.11	1.16	29.03	26.80	0	0	0.28	0.11	3.60	2.42	2.47	2.04	0	0	16.46	12.72	0	0
TOTAL SHELLFISH	**7.26**	**3.83**	**2.11**	**1.16**	**29.03**	**26.80**	**0**	**0**	**0.28**	**0.11**	**3.60**	**2.42**	**2.47**	**2.04**	**0**	**0**	**16.46**	**12.72**	**0**	**0**
GRAND TOTAL	**63.02**	**91.11**	**51.50**	**79.92**	**57.30**	**75.89**	**7.57**	**11.73**	**11.60**	**18.01**	**14.10**	**23.19**	**3.10**	**2.80**	**52.93**	**1.73**	**17.80**	**14.30**	**0.41**	**0.55**

Source:
Auil-Marshalleck et al. (2001).
Culbertson et al. (2004).

Many organisms, including mollusks, polychaetes, barnacles, crabs, gastropods, amphipods, polychaetes, and isopods, can be found living on the oyster reef, forming a very diverse community (Sheridan et al., 1989). Oyster reef communities are dependent upon food resources from the open bay and marshes. Many organisms feed on oysters including fish, such as black drum, crabs (*Callinectes* spp.), and gastropods such as the oyster drill (*Thais haemastoma*) (Sheridan et al., 1989; Lester and Gonzales, 2001). When oyster reefs are exposed during low tides, shore birds would use the reef areas as resting places (Armstrong et al., 1987).

The majority of oyster reefs in the study area are located in the southern part of Sabine Lake near Blue Buck Point, in Sabine Pass, and in Keith Lake (GLO, 1996). Oysters are not commercially harvested from Sabine Lake. In Texas, all areas not specifically designated as Restricted, Conditionally Approved, or Approved by the Texas Department of State Health Services (TDSHS) are classified as Prohibited and closed for harvesting of molluscan shellfish (Heideman, 2002; TDSHS, 2008). Louisiana has designated Sabine Lake as a “Public Oyster Area.” Commercial harvesting is prohibited and public harvesting methods are restricted to tonging. However, Sabine Lake and its tributaries north of a line from Texas Point to Louisiana are closed to oyster harvesting.

3.10.2.1.4 Salt Marsh

Sabine Lake has the largest salt marsh coverage (over 185,000 acres) of any bay system in Texas (Blackburn et al., 2001). This emergent vegetation plays an important role in sustaining the health and abundance of life in the estuary. Emergent vegetation contributes to the productivity of the estuary by providing particulate matter, nutrients, structure, protection, substrate, habitat for estuarine species, flood control, and improved water quality. Salt marshes serve as spawning and nursery grounds for many fish and shellfish species (Sheridan et al., 1989; TPWD, 1997). As an example, Table 3.10-1 lists species that have been collected from Bessie Heights Marsh. Refer to subsection 3.9.2.1 for a more detailed description of this habitat type.

3.10.2.2 Offshore Habitats and Fauna

The Gulf is a partially enclosed, oceanic basin connected to the Atlantic Ocean by the Straits of Florida and to the Caribbean Sea by the Yucatan Canal. Numerous currents circulate water throughout the basin. Surface temperatures range from 57°F in January to 88°F in July (GMFMC, 2004). Salinities also vary seasonally ranging from 29 ppt near the coastline to 32 ppt in the open Gulf (Minerals Management Service [MMS], 1997). The nearshore area is predominantly composed of coarse sediments, while fine sediments are found in the deeper areas beyond the 260-foot contour (GMFMC, 2004). Sediment type plays an important role in determining community structure. Each species has optimal habitat and tolerance limits regarding sediment particle size and chemical composition that influences the distribution of fauna in nearshore waters (Britton and Morton, 1989).

3.10.2.2.1 Offshore Sands

There are few seagrasses or attached algae found in the offshore sands due to the strong currents and unstable sediments. Most of the bottom surface is populated with macroinfauna such as an occasional hermit crab, portunid crab, or ray. Even though there is little life on the sand surface itself, the overlying waters are highly productive. Phytoplankton are abundant, including microscopic diatoms, dinoflagellates, and other algae (Britton and Morton, 1989).

Much of the faunal diversity lies buried in the sand and relies on the phytoplankton for food. Bivalves found in offshore sands include the blood ark (*Anadara ovalis*), incongruous ark (*A. brasiliana*), southern quahog (*Mercenaria campechiensis*), giant cockle (*Dinocardium robustum*), disk dosinia (*Dosinia discus*), pen shells (*Atrina serrata*), common egg cockle (*Laevicardium laevigatum*), cross-barred venus (*Chione cancellata*), tellins (*Tellina* spp.), and the tusk shell (*Dentalium texasianum*). One of the most common species occurring in the shallow offshore sands is the sand dollar (*Mellita quinquiesperforata*) as well as several species of brittle stars (*Hemipholis elongata*, *Ophiolepis elegans*, and *Ophiothrix angulata*). Many gastropods are common, including the moon snail (*Polinices duplicatus*), ear snail (*Sinum perspectivum*), Texas olive (*Oliva sayana*), Atlantic auger (T*erebra dislocata*), Salle's ager (*Terebra salleano*), scotch bonnet (*Phalium granulatum*), distroted triton (*Distrosio clathrata*), wentletraps (*Epitonium* sp.), and whelks (*Busycon* spp.). Crustaceans inhabit these waters including white and brown shrimp (both commercially caught species), rock shrimp (*Sicyonia brevirostris*), blue crabs, mole crabs (*Albunea* spp.), speckled crab (*Arenaeus cribrarius*), box crab (*Calappa sulcata*), calico crab (*Hepatus epheliticus*), and pea crab (*Pinotheres maculatus*). The most abundant infaunal organism, with respect to the number of individuals, are the polychaetes (Capitellidae, Orbiniidae, Magelonidae, and Paraonidae) (Britton and Morton, 1989).

3.10.2.2.2 Artificial Reefs

In the Gulf, two types of artificial reefs exist, those structures placed to serve as oil and gas production platforms and those intentionally placed to serve as artificial reefs (GMFMC, 2004). The more than 4,500 oil and gas structures in the Gulf form unique reef ecosystems that extend throughout the water column providing a large volume and surface area, dynamic water-flow characteristics, and a strong profile (Ditton and Falk, 1981; Dokken, 1997; Stanley and Wilson, 1990; Vitale and Dokken, 2000). Fish are attracted to oil platforms because these structures provide food, shelter from predators and ocean currents, and a visual reference, which aids in navigation for migrating fishes (Bohnsack, 1989; Duedall and Champ, 1991; Meier, 1989; Vitale and Dokken, 2000). The size and shape of the structure affect community characteristics of pelagic, demersal, and benthic fishes (Stanley and Wilson, 1990). Many scientists feel that the presence of oil platform structures allows for the fish populations to grow, which increases fishery potential (Scarborough-Bull and Kendall, 1992).

The Texas Artificial Reef Program, administered by the TPWD, comprises three concepts. These are Rigs to Reefs, which provides for the recycling of obsolete petroleum platforms into permanent artificial reefs rather than allowing them to be taken ashore as scrap; Ships to Reefs, which at present only includes 12

Liberty Ships from the 1970s and the USTS *Texas Clipper*; and the Near Shore/Shallow Reef program, which is in water too shallow for rigs or ships and uses obsolete bridge and road-bed material and nonfunctional preformed concrete structures like culverts. There are three Near Shore/Shallow Reef sites that are relatively near the proposed new ODMDSs for the Entrance Channel Extension: Basco's Reef, SALT Reef, and Sabine Reef (Appendix B). Basco's Reef (HI-117) is located 23 nautical miles from Sabine Pass in 50 feet of water and has received numerous donations. SALT Reef (HI-85, 18 nautical miles from Sabine Pass, 43 feet of water) and Sabine Reef (HI-117, 22 nautical miles from Sabine Pass, 36 feet of water) have not yet received donations but are formally part of the Artificial Reef Program. SALT Reef, which is closest to the proposed ODMDSs, is 6.6 miles from ODMDS B.

Artificial reefs are colonized by a diverse array of microorganisms, algae, and sessile invertebrates including shelled forms (barnacles, oysters, and mussels), as well as soft corals (bryozoans, hydroids, sponges, and octocorals) and hard corals (encrusting, colonial forms). These organisms (referred to as the biofouling community) provide habitat and food for many motile invertebrates and fishes (GMFMC, 2004).

Species associated with the platforms that are not dependent on the biofouling community for food or cover include the Atlantic spadefish (*Chaetodipterus faber*), lookdown (*Selene vomer*), Atlantic moonfish (*S. setapinnis*), creole-fish (*Paranthias furcifer*), whitespotted soapfish (*Rypticus maculatus*), gray triggerfish (*Balistes capriscus*), and lane snapper (*Lutjanus synagris*), all transients (move from platform to platform) and resident species (always found on the platforms) including red snapper, large tomate (*Haemulon aurolineatum*), and some large groupers. Other resident species that are dependent upon the biofouling community for food or cover include numerous species of blennies, sheepshead, small grazers (butterflyfishes, Chaetodontidae). Highly transient, large predators associated with these structures include barracuda (*Sphyraena barracuda*), almaco jack (*Seriola rivoliana*), hammerhead sharks (*Sphryna* spp.), cobia (*Rachycentron canadum*), mackerels (*Scombridae*), other jacks (*Caranx* sp.), and the little tunny (*Euthynnus alleteratus*) (GMFMC, 2004).

3.10.2.3 Essential Fish Habitat

The DEIS initiated EFH consultation under the Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA). Congress enacted amendments to the MSFCMA (PL 94-265) in 1996 that established procedures for identifying EFH and required interagency coordination to further the conservation of federally managed fisheries. Rules published by the NMFS (50 CFR Sections 600.805–600.930) specify that any Federal agency that authorizes, funds or undertakes, or proposes to authorize, fund, or undertake an activity that could adversely affect EFH is subject to the consultation provisions of the above-mentioned act and identifies consultation requirements. A letter (Appendix A) was submitted to NMFS requesting a list of EFHs in the study area.

The GMFMC has identified the study area as EFH for adult and juvenile brown and white shrimp, red drum, red snapper, lane snapper, greater amberjack (*Seriola dumerilli*), king mackerel, Spanish mackerel

(*Scomberomorus maculatus*), cobia, Gulf stone crab (*Menippe adina*), gag grouper (*Mycteroperca microlepis*), scamp (*Mycteroperca phenax*), and adult gray snapper (*L. griseus*).

EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." When referring to estuaries, it is further defined as "all waters and substrates (mud, sand, shell, rock, and associated biological communities) within these estuarine boundaries, including the sub-tidal vegetation (seagrasses and algae) and adjacent tidal vegetation (marshes and mangroves)" (GMFMC, 2004). No Habitat Areas of Particular Concern (HAPC) identified by the GMFMC are located within the study area.

The following describes the preferred habitat, life history stages, and relative abundance of each EFH managed species based on information provided by GMFMC (2004). Table 3.10-5 describes EFH for each of these species.

Brown Shrimp. Brown shrimp eggs are demersal and are deposited offshore. The larvae begin to migrate through passes with flood tides into estuaries as postlarvae. Migrating occurs at night mainly from February to April, with a minor peak in the fall. Brown shrimp postlarvae and juveniles are associated with shallow vegetated habitats in estuaries, but are also found over silty sand and nonvegetated mud bottoms. Postlarvae and juveniles occur in salinity ranging from 0 to 70 ppt. The density of late postlarvae and juvenile brown shrimp are highest in marsh-edge habitat and submerged vegetation, followed by tidal creeks, inner marsh, shallow, open water, and oyster reefs. Muddy substrates seem to be preferred in unvegetated areas. Juvenile and subadult brown shrimp can be found from secondary estuarine channels out to the continental shelf, but prefer shallow estuarine habitats, such as soft, muddy areas associated with plant-water interfaces. Subadult brown shrimp migrate from estuaries, at night, on ebb tides during new and full moon phases in the Gulf. Their abundance offshore correlates positively with turbidity and negatively with hypoxia (low levels of oxygen in the water). Adult brown shrimp inhabit neritic Gulf waters (marine waters extending from mean low tide to the edge of the continental shelf) and are associated with silt, muddy sand, and sandy substrates (GMFMC, 2004). Adult brown shrimp are common within the Sabine Lake estuary during the spring and summer months, while juveniles are abundant in this area in the spring, summer, and fall.

Larval brown shrimp feed on phytoplankton and zooplankton. Postlarvae brown shrimp feed on phytoplankton, epiphytes, and detritus. Juvenile and adult brown shrimp prey on amphipods, polychaetes, and chironomid larvae, but graze on algae and detritus (Pattillo et al., 1997).

White Shrimp. White shrimp inhabit Gulf and estuarine waters and are pelagic or demersal, depending on their life stage. Their eggs are demersal and larval stages are planktonic, and both occur in nearshore Gulf waters. Postlarvae migrate into estuaries through passes from May to November with most migration occurring in June and September. Migration is in the upper 6.5 feet of the water column at night and at mid-depths during the day. Postlarval white shrimp become benthic once they reach the estuary. Here they seek shallow water with mud or sand bottoms high in organic detritus or rich marsh where they develop into juvenile white shrimp. Postlarvae and juveniles prefer mud or peat bottoms with large

Table 3.10-5
Essential Fish Habitat – Adult and Juvenile Presence
in the Sabine-Neches Study Area

Species	ESTUARINE		MARINE	
	Adults	Juvenile	Adults	Juvenile
Brown Shrimp (*Farfantepenaeus aztecus*)	*common* March–May June–July *rare* August–October November–February	*abundant* March–May June–July August–October *common* November–February	major adult area spring, summer, fall spawn year-round at depths greater than 13 meters	spawning area
White Shrimp (*Litopenaeus setiferus*)	*common* March–May June–July *highly abundant* August–October November–February	*highly abundant* March–May June–July August–October November–February	adult area year-round	not present
Red Drum (*Sciaenops ocellatus*)	*rare* March–May June–July August–October November–February *common in Sabine Pass* June–July August–October November–February	*common* March–May June–July August–October November–February	adult area year-round spawn in coastal waters in the fall and winter	not present
Gag Grouper (*Mycteroperca microlepis*)	not present	nursery area	adult occurrence	not present
Scamp (*Mycteroperca phenax*)	not present	not present	adult occurrence	not present
Red Snapper (*Lutjanus campechanus*)	not present	not present	adult occurrence	nursery area year-round
Gray Snapper (*Lutjanus griseus*)	not present	nursery area	major adult area year-round spawn June–August	not present
Lane Snapper (*Lutjanus synagris*)	not present	nursery area	adult occurrence	nursery area
Greater Amberjack (*Seriola dumerilli*)	not present	not present	adult area year-round year-round spawning	nursery area year-round
King Mackerel (*Scomberomorus cavalla*)	not present	not present	adult area year-round spawn May–November	year-round nursery area
Spanish Mackerel (*Scomberomorus maculatus*)	*rare* March–May June–July August–October November–February *common in Sabine Pass* June–July August–October	*rare* March–May June–July August–October *not present* March–May (in certain areas) November–February	adult area year-round	nursery area year-round

Table 3.10-5, cont'd

Species	ESTUARINE Adults	ESTUARINE Juvenile	MARINE Adults	MARINE Juvenile
Cobia (*Rachycentron canadum*)	not present	not present	adult area summer spawn in spring and summer	nursery area year-round
Gulf Stone Crab (*Menippe adina*)	*rare to not present* March–May June–July August–October November–February	*rare to not present* March–May June–July August–October November–February	adult area year-round spawning from March–October	spawning area March–October

quantities of decaying organic matter or SAV. Densities are usually highest along marsh edge and in SAV, followed by marsh ponds and channels, inner marsh, and oyster reefs. White shrimp juveniles prefer salinities of less than 10 ppt and occur in tidal rivers and tributaries. As white shrimp juveniles mature, they migrate to coastal areas where they mature and spawn. Adult white shrimp are demersal and inhabit soft mud or silt bottoms (GMFMC, 2004). Adult and juvenile white shrimp are abundant in the Sabine Lake estuary throughout the year. Adult white shrimp also occur throughout the Gulf to depths of about 131 feet.

White shrimp larvae feed on phytoplankton and zooplankton. White shrimp postlarvae feed on phytoplankton, epiphytes, and detritus. Juvenile and adult white shrimp prey on amphipods, polychaetes, and chironomid larvae, but also graze on algae and detritus (Pattillo et al., 1997).

Red Drum. Red drum occupy a variety of habitats, ranging from offshore depths of 131 feet to very shallow estuarine waters. Spawning occurs in the Gulf near the mouths of bays and inlets during the fall and early winter. Eggs usually hatch in the Gulf, and larvae are transported with tidal currents into the estuaries where they mature. Adult red drum use estuaries, but tend to migrate offshore where they spend most of their adult life. Red drum occur over a variety of substrates including sand, mud, and oyster reefs and can tolerate a wide range of salinities (GMFMC, 2004).

Estuaries are especially important to larval, juvenile, and subadult red drum. Juvenile red drum are most abundant around marshes, preferring quiet, shallow, protected waters over mud substrate or among SAV. Subadult and adult red drum prefer shallow bay bottoms and oyster reefs (GMFMC, 2004). Adult red drum that migrate into the Gulf are pelagic.

Estuaries are also important for the prey of larval, juvenile, and subadult red drum. Red drum larva feed primarily on shrimp, mysids, and amphipods, while juvenile red drum prefer fish and crabs. Adult red drum feed primarily on shrimp, blue crab, striped mullet, and pinfish (GMFMC, 2004). Within the Sabine Lake estuary, adult and juvenile red drum are common in the summer, fall, and winter, whereas in the Gulf, adult red drum are present year-round.

Gag Grouper. Gag grouper are demersal and are most common in the eastern Gulf. Eggs are pelagic and are spawned from December through April. Larvae are pelagic and most abundant in the early spring.

Postlarvae and pelagic juveniles move through inlets into high salinity estuaries from April through May, where they become benthic and settle into grass flats and oyster beds. Older juveniles move offshore in the fall to shallow reef habitat in depths of 3 to 165 feet. Adults prefer depths of 33 to 328 feet and utilize hard bottoms, oil platforms, and artificial reefs. Spawning occurs on the west Florida shelf from December through April (GMFMC, 2004).

Gag grouper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs during their juvenile stages. As they mature and move farther offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult gag grouper occur in Gulf waters within the study area.

Scamp. Scamp are demersal and widely distributed on shelf areas of the Gulf. Scamp eggs and larvae are pelagic and are spawned offshore in the spring. Juvenile scamp occur on shallow, nearshore hard bottoms and reefs in depths of 40 to 620 feet. Scamp spawn in aggregations from late February to early June.

Juvenile scamp feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. As they mature and move offshore, they become opportunistic predators, feeding on a variety of fish and crustaceans (GMFMC, 2004). Adult scamp occur in Gulf waters within the study area.

Red Snapper. Red snapper are demersal and found over sand and rock substrates around reefs, and underwater objects to depths of 656 feet. However, adult red snapper prefer depths ranging from 131 to 360 feet (GMFMC, 2004). Spawning occurs in the Gulf from May to October, at depths of 60 to 122 feet over fine sand substrate. Larvae, postlarvae, and early juveniles occur from July through November in shelf waters. Early and late juveniles are often associated with underwater structures or small burrows, but are also abundant over barren sand and mud bottoms.

Juvenile red snapper feed on shrimp, but after age one, prey primarily on fish and squid. Of the vertebrates consumed, most are not obligate reef dwellers, indicating that red snapper feed away from reefs (GMFMC, 2004). All life stages of the red snapper occur in the Gulf waters within the study area.

Gray Snapper. Gray snapper can be demersal, structure, or mid-water dwellers inhabiting marine, estuarine, and riverine habitats. They inhabit depths to about 550 feet in the Gulf. Juvenile gray snapper are common in shallow water around SAV while adult gray snapper tend to congregate in deeper Gulf waters around natural and artificial reefs. Spawning occurs in the Gulf from June to August around structures and shoals. Their eggs are pelagic and the larvae are planktonic, both occurring in Gulf shelf waters and near coral reefs. Postlarvae migrate into the estuaries and are most abundant over *Halodule* and *Syringodium* grassbeds. Juveniles seem to prefer *Thalassia* grassbeds, seagrass meadows, marl bottoms, and mangrove roots, and are found in estuaries, bayous, channels, grassbeds, marshes, mangrove swamps, ponds, and freshwater creeks (GMFMC, 2004).

Juvenile gray snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Gray snapper are classified as opportunistic carnivores at all life stages (Pattillo et al., 1997). In estuaries, juvenile gray snapper feed on shrimp, larval fish, amphipods, and copepods. Adult gray snapper feed primarily on fish, but smaller individuals will prey on crustaceans (GMFMC, 2004). Only adult gray snapper are found in the Gulf waters of the study area.

Lane Snapper. Lane snapper are demersal, occurring over all substrate types, but are most commonly found near coral reefs and sandy bottoms. Spawning occurs in Gulf waters from March through September. Nursery areas include mangrove and grassy estuarine habitats in southern Texas and Florida and shallow waters with sand and mud bottoms along all Gulf states. Juvenile lane snapper appear to favor grass flats, reefs, and soft bottoms to depths of 66 feet. Adult lane snapper occur offshore in depths ranging from 13 to 433 feet near sand bottoms, natural channels, banks, and artificial and natural structures (GMFMC, 2004).

Juvenile lane snapper feed on estuarine-dependent organisms such as shrimp, small fish, and crabs. Lane snapper are considered to be unspecialized, opportunistic predators, feeding on a variety of crustaceans and fish. However, adult lane snapper tend to prefer fish (GMFMC, 2004). Juvenile lane snapper are found in estuaries and marine waters, while adults are found only in marine waters.

Greater Amberjack. Greater amberjack occur throughout the Gulf to depths of 1,300 feet. Adults are pelagic and epibenthic, occurring near reefs and artificial structures. Spawning occurs offshore, and juvenile greater amberjack are associated with floating *Sargassum* and debris (GMFMC, 2004). Adult and juvenile greater amberjack are found in the Gulf within the study area.

King Mackerel. King mackerel are pelagic and found in Gulf waters from nearshore to 655 feet. Spawning occurs in the Gulf from May to October. Eggs are pelagic, occurring over depths of 98 to 590 feet. Nursery areas are located in marine waters with juveniles only occasionally entering estuaries (GMFMC, 2004).

While estuaries are important for most of their prey, king mackerel feed on a variety of fishes, but extensively utilizing herrings. Squid, shrimp, and other crustaceans are also fed upon by king mackerel. Adult and juvenile king mackerel are found in the Gulf within the study area.

Spanish Mackerel. Spanish mackerel are pelagic, inhabiting depths to 245 feet throughout the coastal zone of the Gulf. Adult Spanish mackerel are usually found from nearshore to the edge of the continental shelf. However, they may also migrate seasonally into estuaries with high salinity, but this migration is infrequent and rare. Spawning occurs in the Gulf from May through October. Larvae typically occur in the Gulf in depths ranging from 30 to 275 feet. Juveniles inhabit the Gulf surf, and sometimes estuarine habitats. However, juvenile Spanish mackerel prefer marine salinities and are not considered estuarine-dependent. Adult and juvenile Spanish mackerel are common in Sabine Pass from June through October. Juvenile Spanish mackerel prefer clean sand bottoms, but the substrate preferences of the other life stages are unknown (GMFMC, 2004).

While Spanish mackerel rarely use estuarine environments, estuaries are important for most of their prey. They feed on a variety of fishes, but extensively utilize herrings. Squid, shrimp, and other crustaceans are also fed upon by Spanish mackerel.

Cobia. Cobia are large, pelagic fish occurring from nearshore to depths of 131 feet near artificial and natural structure, including floating objects. In the study area, cobia occur only in the Gulf and do not use estuarine waters.

While cobia rarely use estuarine environments, estuaries are important for most of their prey. They feed on a variety of fishes, but extensively utilize herrings. Squid, shrimp, and other crustaceans are also fed upon by cobia.

Gulf Stone Crab. Gulf stone crabs occur in the study area, inhabiting the Gulf and the Sabine Lake estuary. Gulf stone crab seek cover under rock ledges, coral heads, dead shell, and grass clumps. They also inhabit burrows in seagrass flats and along the sides of tidal channels. Larval Gulf stone crabs are planktonic, suspended in the water column. Juvenile Gulf stone crabs prefer seagrass flats, channels, shell bottoms, sponges, and *Sargassum* mats. Once they reach a width of 0.5 inch, they live among oyster shells and rocks in shallow estuaries. Adult and juvenile Gulf stone crabs can tolerate a range of salinity; however, larvae require salinities from 30 to 35 ppt for optimal growth. Broad fluctuations in salinity and temperature can result in high mortality of larval Gulf stone crabs (GMFMC, 2004).

Gulf stone crabs are predatory throughout their life. Juvenile Gulf stone crabs feed on polychaetes, molluscs, and crustaceans. Adult Gulf stone crabs feed mainly on oysters and mussels, but also consume dead or decaying tissue and vegetable matter such as seagrass (GMFMC, 2004).

Gulf stone crabs are dependent upon fertile estuarine waters. High phytoplankton productivity in fertile estuarine waters results in food for oysters, worms, and other organisms, which, in turn, provide food for juvenile and adult stone crabs.

3.10.2.4 Ballast Water

Ballast water is loaded on empty ships to provide weight and stability while traveling from one port to the next. There are thousands of marine species that can be carried from port to port in ballast water, which may ultimately result in the introduction of unwanted aquatic species from foreign ports of origin (Global Ballast Water Management Programme, 2002). As a consequence, invasive, exotic species have been introduced into United States waters through ballast water. Ballast water is the largest single vector for nonindigenous species transfer (EPA, 2001). The USCG does not have a list of species of concern (SOC) that could potentially be introduced through ballast water into the study area (Allen, 2002). However, the EPA has compiled a list of invasive species that have the potential to be unintentionally introduced in Texas, although not necessarily through ballast water alone (Table 3.10-6) (EPA, 2001).

The USCG, under the provisions of the National Invasive Species Act, has implemented a program that consists of a suite of mandatory ballast water management protocols. All vessels, foreign and domestic, equipped with ballast water tanks that operate within U.S. waters are required to comply with 33 CFR Part 51 regarding management protocols. This includes submitting a ballast water exchange report to the National Ballast Information Clearinghouse (NBIC) to ensure compliance with the management requirements (USCG, 2006).

Table 3.10-6
Current and Potential Aquatic Species that Pose a Threat to Texas and Louisiana

Scientific Name	Common Name	Texas	Louisiana
Shrimp Viruses			
Taura Syndrome Virus	shrimp virus	4	
White Spot Syndrome Virus	shrimp virus	4	
Coelenterates			
Phyllorhiza punctata	spotted jellyfish	P	P
Roundworms (phylum Nematoda)			
Anguillicola crassus	eel parasite	P	
Mollusks			
Corbicula fluminea	Asian clam	P	P
Crassostrea gigas	Japanese (or Pacific giant) oyster	4	
Dreissena polymorpha	zebra mussel	P	P
Perna perna	brown mussel	P	P
Pomacea canalicula	channeled applesnail	4	
Crustaceans			
Carcinus maenus	green crab	P	P
Charybdis helleri	marine swimming crab	P	P
Eriocheri sinensis	Chinese mittencrab	P	P
Fishes			
Cichlasoma cyanoguttatum	Rio Grande cichlid	4	4
Ctenopharyngodon idella	grass carp	4	4
Hypophthalmichthys molitrix	silver carp	P	4
Hypophthalmichthys nobilis	bighead carp	P	4
Mylopharyngodon piceus	black carp	P	P
Neogobius melanostomus	round goby		P
Oreochromis aureus	blue tilapia	4	
Oreochromis mossambicua	Mozambique tilapia	4	
Mammals			
Myocastor coypus	nutria	4	4
Algae			
Aureoumbra lagunensis	brown tide algae	4*	
Vascular Plants			
Alternathera philoxeroides	alligatorweed	4	4
Eichhornia crassipes	water hyacinth	4	4
Hydrilla verticillata	hydrilla	4	4
Ipomoea aquatica	waterspinach	P	
Lythrum salicaria	purple loosestrife	P	P
Panicum repens	torpedograss	4	
Pistia stratiotes	waterlettuce	4	4
Salvinia minima	common salvinia	4	4
Salvinia molesta	giant salvinia	4	4
Semi-Aquatic Vascular Plants			
Imperata cylindrica	cogongrass		P
Pueraria montana	kudzu	P	4
Sapium sebiferum	Chinese tallow tree	4	4

Source: EPA (2001).

P = Potential threat; 4 = Current threat.

* = Cryptogenic (a species whose status as indigenous or nonindigenous remains unresolved).

According to the NBIC (2007) ballast water–reporting database, between 2000 and 2005, 1,279 ballast water exchange reports were submitted for the study area. Of these, 136 represented treated and 90 represented untreated discharges. Treated discharges consisted of either flow-through or empty/refill of ballast tanks.

3.11 WILDLIFE

Wildlife native to the study area include those that inhabit the Austroriparian Biotic Province (Blair, 1950). Diversity in the study area is high, with large numbers of vertebrate and invertebrate species. The Austroriparian Biotic Province is situated in the eastern portion of Texas and extends southward to the Gulf coast and east through Louisiana to the Atlantic Ocean. The vertebrate fauna of the Austroriparian Biotic Province in Texas and Louisiana, with few exceptions, is the typical vertebrate fauna of the Austroriparian Biotic Province eastward to the Atlantic seaboard. According to Blair (1950), at least 47 species of mammals, 29 species of snakes, 10 lizards, 2 land turtles, 17 anurans, and 18 urodeles occur or have occurred there.

3.11.1 Amphibians

Amphibians common to marsh habitats within the study area are the green treefrog (*Hyla cinerea*), American bullfrog (*Rana catesbeiana*), eastern narrow-mouthed toad (*Gastrophryne carolinensis*), Great Plains narrow-mouthed toad (*G. olivacea*), Blanchard's cricket frog (*Acris crepitans blanchardi*), squirrel treefrog (*H. squirella*), bronze frog (*R. clamitans*), and the southern leopard frog (*R. sphenocephala utricularia*).

Amphibian species that are common to the upland grasslands include the Gulf Coast toad (*Bufo nebulifer*), southern leopard frog, and the northern spring peeper (*Pseudacris crucifer crucifer*).

Amphibian species that are commonly found in forest habitats include the gray treefrog (*H. versicolor*), eastern narrow-mouthed toad, squirrel treefrog, and the Great Plains narrow-mouthed toad (Blair, 1950).

3.11.2 Birds

Avian species known to occur year-round within the study area include herons and egrets (Family Ardeidae), gulls, terns, and skimmers (Family Laridae), Anhinga (*Anhinga anhinga*), turkey vulture (*Cathartes aura*), red-tailed hawk (*Buteo jamaicensis*), eastern screech-owl (*Megascops asio*), red-bellied woodpecker (*Melanerpes carolinus*), American crow (*Corvus brachyrhynchos*), tufted titmouse (*Baeolophus bicolor*), Carolina wren (*Thryothorus ludovicianus*), northern cardinal (*Cardinalis cardinalis*), northern mockingbird (*Mimus polyglottos*), house sparrow (*Passer domesticus*), and blue jay (*Cyanocitta cristata*). Winter migrants that reside within the study area may include the long-billed curlew (*Numenius americanus*), lesser yellowlegs (*Tringa flavipes*), least sandpiper (*Calidris minutilla*), mallard (*Anas platyrhynchos*), short-billed dowitcher (*Limnodromus griseus*), cedar waxwing (*Bombycilla cedrorum*), double-crested cormorant (*Phalacrocorax auritus*), yellow-rumped warbler (*Dendroica cornata*), American coot (*Fulica americana*), white-crowned sparrow (*Zonotrichia *leucophrys*), dark-eyed junco (*Junco hyemalis*), and the American goldfinch (*Spinus tristis*). Migratory waterfowl are known to be abundant in the study area. In the northern reaches of the study area and in the forested wetlands of Pine Island Bayou, wood ducks (*Aix sponsa*) can be found perching in tree cavities. In more-shallow areas, dabbling ducks, also known as “puddle ducks,” can be found in ponded wetlands closely associated with the Neches and Sabine rivers and their tributaries. During winter, they frequent the salt marshes along the immediate coastlines. Some of these species may include northern pintail (*Anas acuta*), American wigeon (*A. americana*), Northern shoveler (*A. clypeata*), green-winged teal (*A. crecca*), cinnamon teal (*A. cyanoptera*), mallard, and gadwall (*A. strepera*). Diving ducks, ducks inhabiting deeper waters such as Sabine Lake, may include redhead (*Aythya americana*), lesser scaup (*A. affinis*), and canvasback (*A. valisineria*). Common geese found foraging in the study area’s agricultural fields and freshwater wetlands as well as roosting in salt marshes include snow goose (*Chen caerulescens),* greater white-fronted goose (*Anser albifrons*), Ross’s goose (*Chen rossii*), and Canada goose (*Branta canadensis*).

Possible transient species that may occur in the study area during winter migration are chuck-will’s-widow (*Caprimulgus carolinensis*), chimney swift (*Chaetura pelagica*), ruby-throated hummingbird (*Archilochus colubris*), eastern kingbird (*Tyrannus tyrannus*), purple martin (*Progne subis*), yellow-throated warbler (*Dendroica dominica*), and the black-and-white warbler (*Mniotilta varia*) (Lockwood and Freeman, 2004).

According to the USFWS Texas Colonial Waterbird Census (USFWS, 2007), 25 documented rookeries occur within the study area. Table 3.11-1 provides information on nesting activities at these rookeries. No documented rookeries occur within the Louisiana portion of the study area (Clark, 2009).

3.11.3 Mammals

Common mammals that inhabit forest habitats in the study area include Virginia opossum (*Didelphis virginiana*), Brazilian free-tailed bat (*Tadarida brasiliensis*), nine-banded armadillo (*Dasypus novemcinctus*), swamp rabbit (*Sylvilagus aquaticus*), eastern red bat (*Lasiurus borealis*), eastern gray squirrel (*Sciurus carolinensis*), eastern fox squirrel (*S. niger*), white-footed mouse (*Peromyscus leucopus*), eastern woodrat (*Neotoma floridana*), northern raccoon (*Procyon lotor*), striped skunk (*Mephitis mephitis*), and coyote (*Canis latrans*).

Mammals common to upland grassland habitats within the study area include the least shrew (*Cryptotis parva*), hispid pocket mouse (*Chaetodipus hispidus*), pygmy mouse (*Baiomys taylori*), coyote, nine-banded armadillo, Baird’s pocket gopher (*Geomys breviceps*), eastern cottontail (*Sylvilagus floridanus*), hispid cotton rat (*Sigmodon hispidus*), and fulvous harvest mouse (*Reithrodontomys fulvescens*).

Mammals that are common to marsh habitat areas include the northern rice rat (*Oryzomys palustris*), nutria (*Myocastor coypus*), swamp rabbit, least shrew, coyote, striped skunk, Virginia opossum, bobcat (*Lynx rufus*), Attwater’s pocket gopher (*G. attwateri*), northern raccoon, and common muskrat (*Ondatra zibethicus*) (Blair, 1950).

Table 3.11-1
Number of Nests of Colonial Waterbirds at Selected Rookeries in the Study Area

Rookery/ID	Common Name	Scientific Name	Census Year 2001	2002	2003	2004	2005
McFadden/587-120	N/A						
Beaumont Ship Channel/587-121	N/A						
Nederland Spoil Area/587-122	Neotropic cormorant	*Phalacrocorax brasilianus*	55				
	Anhinga	*Anhinga anhinga*	4				
	Great egret	*Ardea alba*	55				
	Snowy egret	*Egretta thula*	25				
	Little blue heron	*Egretta caerulea*	5				
	Tricolored heron	*Egretta tricolor*	12				
	Cattle egret	*Bubulcus ibis*	140				
	Black-crowned night-heron	*Nycticorax nycticorax*	2				
	White-faced ibis	*Plegadis chihi*	2				
	Roseate spoonbill	*Platalea ajaja*	13				
DuPont Spoils Area XPNSN/587-123	Neotropic cormorant	*Phalacrocorax brasilianus*		10	40		10
	Anhinga	*Anhinga anhinga*		1	4		
	Great egret	*Ardea alba*		2	70		17
	Snowy egret	*Egretta thula*		25	60		20
	Little blue heron	*Egretta caerulea*		25	35		
	Tricolored heron	*Egretta tricolor*		20	45		14
	Cattle egret	*Bubulcus ibis*		300	260		143
	Black-crowned night-heron	*Nycticorax nycticorax*			1		
	Yellow-crowned night-heron	*Nyctanassa violacea*		2			
	Roseate spoonbill	*Platalea ajaja*		2			
Shangrila/588-009	Neotropic cormorant	*Phalacrocorax brasilianus*				50	107
	Anhinga	*Anhinga anhinga*				0	4
	Great egret	*Ardea alba*	15			350	275
	Cattle egret	*Bubulcus ibis*	30			150	350
	Roseate spoonbill	*Platalea ajaja*	5			6	4
Taylor Bayou/600-052	N/A						
Texaco/601-100	N/A						
Texaco Parking Lot/601-101	N/A						
Motiva Savannah Ave./601-102	N/A						
Motiva Headquarters/601-103	Least tern	*Sternula antillarum*	15	35	8	30	50
	Black skimmer	*Rynchops niger*	2				

Table 3.11-1, cont'd

Rookery/ID	Common Name	Scientific Name	Census Year 2001	2002	2003	2004	2005
Motiva Old FCC Area/601-104	Least tern	*Sternula antillarum*	45	15	9	17	
Motiva West of Headquarters/601-105	Least tern	*Sternula antillarum*		7	8	70	100
	Black skimmer	*Rynchops niger*		45		1	
Sydney Island/601-120	Neotropic cormorant	*Phalacrocorax brasilianus*					300
	Great egret	*Ardea alba*					500
	Snowy egret	*Egretta thula*					221
	Tricolored heron	*Egretta tricolor*					140
	Black-crowned night-heron	*Nycticorax nycticorax*					12
	White ibis	*Eudocimus albus*					2,000
	Roseate spoonbill	*Platalea ajaja*					250
Dooms Island/601-121	N/A						
Point Hunt Island, Louisiana/601-122	Neotropic cormorant	*Phalacrocorax brasilianus*			20	40	300
	Double-crested cormorant	*Phalacrocorax auritus*				4	
	Great egret	*Ardea alba*			130	50	500
	Snowy egret	*Egretta thula*			120	40	221
	Little blue heron	*Egretta caerulea*			2	15	
	Tricolored heron	*Egretta tricolor*			80		140
	Cattle egret	*Bubulcus ibis*				9	
	Black-crowned night-heron	*Nycticorax nycticorax*			2	20	12
	Yellow-crowned night-heron	*Nyctanassa violacea*				4	
	White ibis	*Eudocimus albus*				300	2,000
	White-faced ibis	*Plegadis chihi*			80		
	Roseate spoonbill	*Platalea ajaja*			100	80	250
Port Arthur/ICWW Bridge/601-140	N/A						
Gulf Oil Pit/601-141	N/A						
Chevron Plant/601-142	N/A						
Motiva West 7th St./601-144	Neotropic cormorant	*Phalacrocorax brasilianus*	7	20	50	140	90
	Anhinga	*Anhinga anhinga*		1			
	Great egret	*Ardea alba*	25	110	110	68	52

Table 3.11-1, concluded

Rookery/ID	Common Name	Scientific Name	Census Year				
			2001	2002	2003	2004	2005
	Snowy egret	*Egretta thula*	50	30	30	37	76
	Little blue heron	*Egretta caerulea*	4		4	6	20
	Tricolored heron	*Egretta tricolor*	15	10	8	10	
	Cattle egret	*Bubulcus ibis*	50	50	40	50	22
	Black-crowned night-heron	*Nycticorax nycticorax*	20	12	7	3	3
	Yellow-crowned night-heron	*Nyctanassa violacea*	1		1		
	White ibis	*Eudocimus albus*			1	4	10
	White-faced ibis	*Plegadis chihi*			1		10
	Roseate spoonbill	*Platalea ajaja*	60	55	45	25	6
Backridge Road/601-145	N/A						
Premcor/601-146	Least tern	*Sternula antillarum*		197	50		
Beaumonts Cattail Marsh/601-147	Cattle egret	*Bubulcus ibis*		40	6		
Texas Point NWR/601-150	N/A						
United Marine Enterprise/601-151	N/A						
Sabine Pass/601-160	N/A						

Source: Texas Colonial Waterbird Census Database (USFWS, 2007).

3.11.4 Reptiles

Reptiles known to inhabit forested habitats in the study area are the little brown skink (*Scincella lateralis*), Texas ratsnake (*Elaphe obsoleta*), rough greensnake (*Opheodrys aestivus*), eastern gartersnake (*Thamnophis sirtalis sirtalis*), Texas coralsnake (*Micrurus tener*), and southern copperhead (*Agkistrodon contortrix contortrix*).

Reptiles common to upland grassland habitats include the three-toed box turtle (*Terrapene carolina triunguis*), ornate box turtle (*Terrapene ornata ornata*), green anole (*Anolis carolinensis*), prairie lizard (*Sceloperus consobrinus*), eastern six-lined racerunner (*Aspidoscelis sexlineata sexlineata*), little brown skink, diamond-backed watersnake (*Nerodia rhombifer rhombifer*), Texas ratsnake, Texas spotted whiptail (*A. gularis gularis*), prairie kingsnake (*Lampropeltis calligaster calligaster*), Mediterranean gecko (*Hemidactylus turcicus turcicus*), Texas coralsnake, and the western diamond-backed rattlesnake (*Crotalus atrox*).

Reptiles common to marsh habitats include the diamond-backed watersnake, snapping turtle (*Chelydra serpentina*), stinkpot (*Sternotherus odoratus*), Mississippi mud turtle (*Kinosternon subrubrum*), red-eared slider (*Trachemys scripta elegans*), Texas ratsnake, speckled kingsnake (*Lampropeltis getula holbrooki*), and the western cottonmouth (*Agkistrodon piscivorous leucostoma*) (Bartlett and Bartlett, 1999).

3.11.5 Insects

Common terrestrial insects that occur within the study area include the field cricket (*Gryllus* sp.), American cockroach (*Periplaneta americana*), wheel bug (*Arilus cristatus*), leaffooted bug (*Leptoglossus phyllopus*), dog-day cicada (*Tibicen* sp.), green lacewing (*Chrysoperla* spp.), ground beetle (*Scarites subterraneus*), June beetle (*Phyllophaga* sp.), firefly (*Photinus* sp.), blister beetle (*Epicauta* sp.), boll weevil (*Anthonomous grandis*), Asian tiger mosquito (*Aedes albopictus*), deer fly (*Chrysops* sp.), house fly (*Musca domestica*), blow fly (*Calliphora* sp.), giant swallowtail (*Heraclides cresphontes*), cloudless sulphur (*Phoebis sennae eubule*), snout butterfly (*Libytheana* sp.), honey bee (*Apis mellifera*), paper wasp (*Polistes carolina*), and the red imported fire ant (*Solenopsis invicta*) (Drees and Jackman, 1998).

3.12 THREATENED AND ENDANGERED SPECIES

Congress enacted the ESA (16 USC 1531 et seq.) of 1973, as amended, to provide a program for the preservation of threatened and endangered species and to provide protection for the ecosystems upon which these species depend for their survival. All Federal agencies are required to implement protection programs for these designated species and to use their authorities to further the purposes of the ESA. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range in the U.S. A threatened species is one likely to become endangered within the foreseeable future throughout all or a significant portion of its range. The USFWS and NMFS are the primary agencies responsible for implementing the ESA. The USFWS is responsible for birds and terrestrial and freshwater species, while the NMFS is responsible for nonbird marine species.

The State of Texas also has regulations to protect endangered species (chapters 67, 68, and 88 of the TPWD Code and sections 65.171–65.184 and 69.01–69.14 of Title 31 of the Texas Administrative Code). These regulations, administered by the TPWD, prohibit commerce in threatened and endangered plants and wildlife and the collection of listed plant species from public land without a permit. In addition, the State of Louisiana, through the LDWF, provides protective status for all threatened and endangered species listed by the USFWS and also to those species listed as threatened or endangered by the State Natural Heritage Program. This assessment addresses State-listed threatened and endangered species; however, the ESA does not protect these species.

Only those species that the USFWS or NMFS lists as threatened and endangered have complete Federal protection under the ESA. Inclusion on the following lists does not imply that a species occurs in the study area, but only acknowledges the potential for occurrence. The USACE prepared a Biological Assessment (BA) to evaluate the potential impacts the SNWW CIP may have on federally listed threatened and endangered species (Appendix G1). The NMFS (n.d.), TPWD’s Natural Diversity Database (NDD, 2005a, 2005b), TPWD (2010), and USFWS (2005c, 2009) provided county/parish-level lists of threatened and endangered species of potential occurrence in the study area (Table 3.12-1). In addition, NDD (2006) provided digital map data presenting specific locations of listed species within the study area.

Table 3.12-1
Threatened and Endangered Species[1] of Potential Occurrence
Within the Study Area

Common Name[2]	Scientific Name[2]	Status[3]	
		Federal	State
BIRDS			
Brown pelican[4]	*Pelecanus occidentalis*	DL	E
Red-cockaded woodpecker	*Picoides borealis*	E	E
Piping plover	*Charadrius melodus*	T w/CH	T
Peregrine falcon[4]	*Falco peregrinus*	DL	T
Bald eagle[4]	*Haliaeetus leucocephalus*	DL	T
Reddish egret	*Egretta rufescens*	NL	T
White-faced ibis	*Plegadis chihi*	NL	T
Wood stork	*Mycteria americana*	NL	T
Swallow-tailed kite	*Elanoides forficatus*	NL	T
Sooty tern	*Onychoprion fuscatus*	NL	T
MAMMALS			
Red wolf	*Canis rufus*	E	E
Sei whale	*Balaenoptera borealis*	E	NL
Blue whale	*Balaenoptera musculus*	E	E
Finback whale	*Balaenoptera physalus*	E	E
Humpback whale	*Megaptera novaeangliae*	E	NL
Sperm whale	*Physeter macrocephalus*	E	E
West Indian manatee	*Trichechus manatus*	E	E
Louisiana black bear	*Ursus americanus luteolus*	T	T
Black bear	*Ursus americanus*	T/SA; NL	T
Rafinesque's big-eared bat	*Corynorhinus rafinesquii*	NL	T
REPTILES			
Leatherback sea turtle	*Dermochelys coriacea*	E	E
Hawksbill sea turtle	*Eretmochelys imbricata*	E	E
Kemp's ridley sea turtle	*Lepidochelys kempii*	E	E
Loggerhead sea turtle	*Caretta caretta*	T	T
Green sea turtle	*Chelonia mydas*	T	T
Texas horned lizard	*Phrynosoma cornutum*	NL	T
Northern scarletsnake	*Cemophora coccinea copei*	NL	T
Timber rattlesnake	*Crotalus horridus*	NL	T
Alligator snapping turtle	*Macrochelys temminckii*	NL	T
FISH			
Smalltooth sawfish	*Pristis pectinata*	E	E
Gulf sturgeon	*Acipenser oxyrhinchus desotoi*	T	NL
Dusky shark	*Carcharhinus obscurus*	SOC	NL
Sand tiger shark	*Carcharias taurus*	SOC	NL
Night shark	*Carcharhinus signatus*	SOC	NL
Saltmarsh topminnow	*Fundulus jenkinsi*	SOC	NL
Warsaw grouper	*Epinephelus nigritus*	SOC	NL

Table 3.12-1, cont'd

Common Name[2]	Scientific Name[2]	Status[3] Federal	State
Speckled hind	*Epinephelus drummondhayi*	SOC	NL
INVERTEBRATES			
Elkhorn coral	*Acropora palmata*	T	NL
Staghorn coral	*Acropora cervicornis*	T	NL
Ivory tree coral	*Oculina varicose*	SOC	NL

[1] According to USFWS (2009), NMFS (n.d.), NDD (2005a, 2005b, 2006), and TPWD (2010).

[2] Nomenclature and taxonomic orders follow American Ornithologists' Union (AOU, 1998, 2000, 2002, 2003, 2004, 2005, 2006, 2007), Crother et al. (2000, 2001, 2003), Baker et al. (2003), Hubbs et al. (2008), NMFS (n.d.), USFWS (2009), TPWD (2010), and NDD (2005a, 2005b).

[3] E = Endangered; species in danger of extinction throughout all or a significant portion of its range; T = Threatened; species which is likely to become endangered within the foreseeable future throughout all or a significant portion of its range; T/SA = Threatened because of similarity of appearance to other listed species; CH = Critical Habitat; SOC = Species of Concern (NMFS); species for which there is some information showing evidence of vulnerability, but not enough data to support listing at this time. These species are afforded no formal protection under the Endangered Species Act of 1973, as amended, but may be protected under other State or Federal laws; DL = Formerly listed as threatened or endangered, but due to significant population increases, has officially been removed from threatened or endangered status.

[4] Recently removed from the Federal list of endangered and threatened species, the brown pelican, the peregrine falcon, and bald eagle retain their state status (74 FR 220:59443–59472; 64 FR 164:46542–46558; 72 FR 130:37346–37372). The brown pelican roosts and nests on islands and spill banks, the peregrine falcon is a statewide migrant in Texas, and bald eagles overwinter on several central Texas lakes (TPWD, 2010).

3.12.1 Insects

No federally listed threatened or endangered insect SOC potentially occur within the study area.

3.12.2 Flora

No federally listed threatened or endangered plant species or plant SOC potentially occurs within the study area.

3.12.3 Fauna

According to the NMFS (n.d), USFWS (2005c, 2009), NDD (2005a, 2005b), and TPWD (2010), 33 federally and/or State-listed threatened and endangered species, and 7 NMFS-designated SOC are of potential occurrence in Jefferson and Orange counties, Texas, and Calcasieu and Cameron parishes, Louisiana (see Table 3.12-1).

Twenty of the 40 species listed in Table 3.12-1 are federally listed as threatened and endangered. These include the endangered red-cockaded woodpecker (*Picoides borealis*), red wolf (*Canis rufus*), sei whale (*Balaenoptera borealis*), blue whale (*B. musculus*), finback whale (*B. physalus*), humpback whale (*Megaptera novaeangliae*), sperm whale (*Physeter macrocephalus*), West Indian manatee (*Trichechus manatus*), leatherback sea turtle (*Dermochelys coriacea*), loggerhead sea turtle (*Caretta caretta*), hawksbill sea turtle (*Eretmochelys imbricata*), Kemp's Ridley sea turtle (*Lepidochelys kempii*), green sea turtle (*Chelonia mydas*), and smalltooth sawfish (*Pristis pectinata*), as well as the threatened, piping plover (*Charadrius melodus*), Louisiana black bear (*Ursus americanus luteolus*), Gulf sturgeon (*Acipenser oxyrhinchus desotoi*), elkhorn coral (*Acropora palmata*), and staghorn coral (*A. cervicornis*). The USFWS lists the black bear *(U. americanus*) as threatened, only because of its similarity in appearance to the Louisiana subspecies of black bear. This designation, however, only applies within the historic range of the Louisiana black bear and not elsewhere.

Thirteen of the 40 species listed in Table 3.12-1 are identified by the TPWD as State-listed threatened species in Texas. These include brown pelican (*Pelecanus occidentalis*), peregrine falcon (*Falco peregrinus*), bald eagle (*Haliaeetus leucocephalus*), reddish egret (*Egretta rufescens*), white-faced ibis (*Plegadis chihi*), wood stork (*Mycteria americana*), swallow-tailed kite (*Elanoides forficatus*), sooty tern (*Onychoprion fuscatus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), Texas horned lizard (*Phrynosoma cornutum*), northern scarletsnake (*Cemophora coccinea copei*), timber rattlesnake (*Crotalus horridus*), and alligator snapping turtle (*Macrochelys temminckii*).

Seven of the 40 species listed in Table 3.12-1 are identified by NMFS as SOC: dusky shark (*Carcharhinus obscurus*), sand tiger shark (*Carcharias taurus*), night shark (*C. signatus*), saltmarsh topminnow (*Fundulus jenkinsi*), Warsaw grouper (*Epinephelus nigritus*), speckled hind (*E. drummondhayi*), and ivory tree coral (*Oculina varicosa*). These species do not receive Federal protection under the ESA.

3.12.3.1 Birds

The historic range of the red-cockaded woodpecker (endangered) included 34 east Texas counties. Currently, only 18 Texas counties support this species (Jackson, 1994; USFWS, 1995). Old-growth pines (60 to 70 years or more), often with the centers rotted by red-heart fungus, are the usual nesting sites, but younger, uninfected pines are also used (Hooper et al., 1980; Jackson, 1994). No known current populations occur in any of the study area counties or parishes, and suitable habitat is absent in the study area. Thus, the species is unlikely to occur in the study area.

The piping plover (threatened) is a small shorebird that inhabits coastal beaches and tidal flats. Approximately 35 percent of the known global population of piping plovers winters along the Texas Gulf Coast, where they spend 60 to 70 percent of the year (Campbell, 1995; Haig and Elliott-Smith, 2004). The piping plover population that winters in Texas breeds on the northern Great Plains and around the Great Lakes. The species is a common migrant and rare to uncommon winter resident on the upper Texas coast (Lockwood and Freeman, 2004; Richardson et al., 1998). The USFWS has designated critical habitat for the species in its nesting and wintering range (65 FR 41781–41812). Designation of critical habitat became final on July 10, 2001 (66 FR 36038–36143). Within Louisiana, the USFWS has designated critical wintering habitat for the piping plover along the entire shoreline from the east side of Sabine Pass (Texas-Louisiana border) east approximately 16 miles to the west end of Constance Beach (Unit LA 1, in part). No USFWS-designated Critical Habitat for the piping plover is present within the Texas portions of the project area.

The USFWS recently removed the peregrine falcon, the brown pelican, and the bald eagle from the Federal list of threatened and endangered species, but the Arctic subspecies (*F. p. tundrius*) and the bald eagle retain their State-listed status of threatened in Texas. The brown pelican retains its State-listed status of endangered in Texas. The Arctic subspecies of peregrine falcon is an uncommon migrant statewide and an uncommon winter resident along the Texas Gulf Coast, where it typically occurs near bays and estuaries (Lockwood and Freeman, 2004). Peregrine falcons may occur within the study area during migration; however, no suitable nesting or wintering habitat is present in the study area. NDD (2006) indicates no documented records from the study area; however, the species may occur in winter or as a transient during migration.

The brown pelican is a common resident along the Texas Gulf Coast, occasionally wandering inland during postbreeding in late summer and fall (Lockwood and Freeman, 2004). Brown pelicans breed on barrier, natural estuarine, or dredged material placement islands (Shields, 2002). Richardson et al. (1998) list the species as an abundant year-round resident on the upper Texas coast, which includes Jefferson County, Texas. Shields (2002) indicates that the species is a winter resident along the western Louisiana coast, but does not breed there. Brown pelicans are unlikely to nest in the study area, but are present throughout most of the year. In 2009, the USFWS removed the brown pelican from the list of threatened and endangered wildlife (74 FR 220; 59443–59472; December 17, 2009); however, the brown pelican still receives Federal protection under the Migratory Bird Treaty Act.

The bald eagle is present year-round in Texas and may be found breeding, wintering, and during migration. In Texas, bald eagles breed along the Gulf Coast and on major inland lakes and reservoirs. Additional numbers of bald eagles winter in these habitats. Bald eagles prefer large bodies of water surrounded by tall trees or cliffs, which they use as nesting sites. In 2007, the USFWS removed the bald eagle from the list of threatened and endangered wildlife (72 FR 130; 37345–37372; July 9, 2007); however, the bald eagle still receives Federal protection under provisions of the Bald and Golden Eagle Protection Act and the Migratory Bird Treaty Act. This species may be present within the study area.

The reddish egret (State threatened) is a common resident along the Texas coast. This species inhabits saline and freshwater habitats in all coastal counties, although it is more numerous southward. The reddish egret is also a rare postbreeding visitor over most of Texas, south of the Panhandle (Oberholser, 1974). It is possible that this species may occur within the study area in areas containing appropriate habitat.

The white-faced ibis (State threatened) is a medium-sized wading bird that inhabits freshwater marshes, sloughs, and irrigated rice fields, but also frequents brackish and saltwater habitats. White-faced ibis are permanent residents along the Texas Gulf Coast; however, nesting records exist for many scattered inland localities (Lockwood and Freeman, 2004; Ryder and Manry, 1994). The species is a common migrant/summer resident and uncommon winter resident on the upper Texas coast (Richardson et al., 1998). NDD (2006) indicates no documented records within the study area; however, the species is likely present year-round in the general area.

The wood stork (State threatened) is an uncommon to locally common postbreeding visitor to coastal Texas and inland waters in east and central Texas (Lockwood and Freeman, 2004). Wood storks historically bred in North America along the Gulf Coast from east Texas to Florida, but their range has significantly declined since the 1960s and their North American breeding range is now restricted to Florida, Georgia, and South Carolina (Coulter et al., 1999; Oberholser, 1974). In Texas, wood storks typically occur near freshwater or saltwater wetlands, lakes, or along rivers and streams. The USFWS lists the wood stork as federally endangered in Florida, Alabama, Georgia, North Carolina, and South Carolina, but not in Texas. Wood storks are uncommon to common in summer and fall along the upper Texas coast (Richardson et al., 1998). The species likely occurs in the study area during summer and fall.

The swallow-tailed kite (State threatened) is a medium-sized raptor that historically occurred along the coastal plains, interior lowlands, and riparian areas throughout the southeastern U.S. and Mississippi River Valley, west to central Texas (Meyer, 1995). Beginning in the late 1800s and early 1900s, this species' U.S. range dramatically decreased, likely because of forestry practices, which resulted in the loss of tall trees used for nesting. Today, swallow-tailed kites breed primarily in Florida, with scattered breeding populations in South Carolina, Georgia, Alabama, Mississippi, Louisiana, and southeastern Texas (Meyer, 1995). In Texas, the species is a rare to uncommon migrant throughout the eastern third of the state, with occasional migration records west to the eastern Edwards Plateau (Lockwood and Freeman, 2004). The species is a rare migrant in the study area, with the majority of records occurring between April and June (Richardson et al., 1998; Shackelford and Simons, 2000). NDD (2006) indicates no records within the study area; however, Shackelford and Simons (2000) indicate recent records of migrating birds, and the species may occur in the study area as a migrant.

The sooty tern (State threatened) is a largely pelagic (open ocean) species that nests on isolated tropical and subtropical islands (Schreiber et al., 2002). The species is a rare and local summer resident along the middle and lower Texas Gulf Coast from Matagorda County to Cameron County, where they nest in small numbers on natural and spoil islands, particularly in the Laguna Madre (Lockwood and Freeman, 2004; Oberholser, 1974). Sooty terns are rare in summer along the upper Texas coast (Richardson et al., 1998). It is unlikely that this oceanic species would regularly occur in the study area; however, their occurrence is possible.

3.12.3.2 Terrestrial Mammals

The red wolf (endangered) formerly inhabited a variety of wooded habitats including pine forests, bottomland hardwood forests, swamps, marshes, and coastal prairies (Schmidly, 2004). Most authorities consider the species extirpated, and red wolves are unlikely to occur in the study area.

The TPWD lists the Louisiana black bear (threatened) as a potentially occurring species in the study area, along with the black bear, because of its similarity in appearance to the Louisiana subspecies. The Louisiana black bear historically inhabited east Texas, Louisiana, and southern Mississippi, but now occurs only in small numbers in Mississippi and Louisiana (USFWS, 1992). The last Texas Pineywoods record of native black bear is from the late 1950s, near the town of Livingston in Polk County (Fleming, 1980). There are periodic reports of black bears from various counties of east Texas; however, these bears most likely represent individuals dispersing from neighboring areas in Louisiana (Taylor, 2000). According to Garner (1995), no recent documented sightings of black bears exist from the Texas Gulf Coast. It is unlikely that either subspecies of black bear would occur in the study area.

Rafinesque's big-eared bat (State threatened) occurs eastward from the Pineywoods of Texas throughout the southeastern U.S. This species roosts most frequently in hollowed trees, beneath bark, and under leaf litter, but often roosts in man-made structures such as buildings, wells, and barns (Schmidly, 1991, 2004). According to Schmidly (2004), documented records exist from Jefferson County, and the species may occur in the study area where appropriate habitat occurs.

3.12.3.3 Aquatic Mammals

NMFS identifies five endangered whale species of potential occurrence in the Gulf. These are the sei whale, blue whale, finback (or fin) whale, humpback whale, and sperm whale. These species are generally restricted to deeper offshore waters; therefore, it is unlikely that any of these five species would regularly occur in the study area (NMFS, 2003).

The West Indian (endangered) manatee historically inhabited the Laguna Madre, Gulf, and tidally influenced portions of rivers. It is currently, however, extremely rare in Texas waters, and the most recent sightings are likely individuals migrating or wandering from Mexican waters. Historical records from Texas waters include Cow Bayou, Sabine Lake, Copano Bay, the Bolivar Peninsula, and the mouth of the Rio Grande (Schmidly, 2004). In May 2005, a live manatee was photographed in the Laguna Madre near Port Mansfield (Blankinship, 2005). The West Indian manatee is chiefly a marine species; however, its occurrence in the study area is unlikely.

3.12.3.4 Reptiles

The leatherback sea turtle (endangered) is probably the most-wide-ranging of all sea turtle species. It occurs in the Atlantic, Pacific, and Indian oceans; as far north as British Columbia, Newfoundland, Great Britain, and Norway; as far south as Australia, Cape of Good Hope, and Argentina; and in other waterbodies such as the Mediterranean Sea (National Fish and Wildlife Laboratory [NFWL], 1980). The leatherback is mainly pelagic, inhabiting the open ocean, and seldom approaches land except for nesting (Eckert, 1992) or when following concentrations of jellyfish (TPWD, 2006), when it can be found in inshore waters, bays, and estuaries. It dives almost continuously, often to great depths. Leatherbacks nest primarily in tropical regions and only sporadically along the Atlantic and Gulf coasts of the continental U.S., with one nesting reported as far north as North Carolina (Schwartz, 1976). In the Atlantic and Caribbean, the largest nesting assemblages occur in the U.S. Virgin Islands, Puerto Rico, and Florida (NMFS, 2006a). No nests of this species have been recorded in Texas for at least 70 years (National Park Service [NPS], 2006); the last two, one from the late 1920s and one from the mid-1930s, were both from Padre Island (Hildebrand, 1982, 1986). Apart from occasional feeding aggregations such as the large one of 100 animals reported by Leary (1957) off Port Aransas in December 1956, or possible concentrations in the Brownsville Eddy in winter (Hildebrand, 1983), leatherbacks are rare along the Texas coast, tending to keep to deeper offshore waters where their primary food source, jellyfish, occurs (NMFS and USFWS, 1992). There are no records of sea turtles nesting on Louisiana Point or anywhere in that area (Firmin, 2006), but documented records of leatherbacks exist from Jefferson County, Texas (Dixon, 2000); however, the species is unlikely to occur in the project area since only one has been captured by a relocation trawler (1.5 miles offshore of Aransas Pass), and there is no record of a take by a hopper dredge (NMFS, 2003).

The hawksbill sea turtle (endangered) is circumtropical, occurring in tropical and subtropical seas of the Atlantic, Pacific, and Indian oceans (Witzell, 1983). This species is probably the most tropical of all marine turtles, although it does occur in many temperate regions. The hawksbill sea turtle is widely distributed in the Caribbean Sea and western Atlantic Ocean, with representatives of at least some life history stages regularly occurring in southern Florida and the northern Gulf (especially Texas), south to Brazil (NMFS, 2006a). The hawksbill sea turtle generally inhabits coastal reefs, bays, rocky areas, passes, estuaries, and lagoons, where it occurs at depths of less than 70 feet. Like some other sea turtle species, hatchlings are sometimes found floating in masses of marine plants (e.g., sargassum rafts) in the open ocean (NFWL, 1980). In the continental U.S., the hawksbill sea turtles largely occur in Florida where they are sporadic at best. In 1998 the first hawksbill sea turtle nest recorded on the Texas coast was found at Padre Island National Seashore. This nest remains the only documented hawksbill sea turtle nest on the Texas coast (NPS, 2006; Shaver 2006). Elsewhere in the western Atlantic, hawksbills nest in small numbers along the Gulf Coast of Mexico, the West Indies, and along the Caribbean coasts of Central and South America (Musick, 1979). Texas is the only state outside of Florida where hawksbills are encountered with any regularity. Most of these sightings involve posthatchlings and juveniles, and are primarily associated with stone jetties. These small hawksbill sea turtles are believed to originate from nesting beaches in Mexico (NMFS, 2006a). There are no records of hawksbill sea turtles nesting on Louisiana Point or anywhere in that area (Firmin, 2006); no documented records of hawksbill sea turtles exist from Jefferson or Orange counties, Texas (Dixon, 2000), and they are not expected to be present in the project area.

The Kemp's ridley sea turtle (endangered) inhabits shallow coastal and estuarine waters, usually over sand or mud bottoms. Adults are primarily restricted to the Gulf, although juveniles may range throughout the Atlantic Ocean since they have been observed as far north as Nova Scotia (Musick, 1979) and in coastal waters of Europe (Brongersma, 1972). Almost the entire population of Kemp's ridley sea turtles nests on an 11-mile stretch of coastline near Rancho Nuevo, Tamaulipas, Mexico, approximately 190 miles south of the Rio Grande. Sporadic nesting has been reported from Mustang Island, Texas, southward to Isla Aquada, Campeche. Kemp's ridley sea turtles occur in Texas in small numbers and in many cases may well be in transit between crustacean-rich feeding areas in the northern Gulf and breeding grounds in Mexico. It has nested sporadically in Texas in the last 50 years. The number of nestings in Texas, however, has increased over the last decade from 4 nests in 1995 to 51 nests in 2005, 28 of which were from the Padre Island National Seashore (NPS, 2006; Shaver, 2006). Several of the ridley nests were from headstarted individuals. Such nestings, together with the proximity of the Rancho Nuevo rookery, probably account for the occurrence of hatchlings and subadults in Texas. Between 1996 and 2005, maintenance dredging in the Sabine Pass Entrance Channel by hopper dredges resulted in the lethal take of a Kemp's ridley sea turtle in 1997 (Rob Hauch, pers. comm., 2006). In 2006, maintenance dredging in the Sabine Bank Channel resulted in the lethal take of one Kemp's ridley sea turtle (USACE, 2006c). The species is of potential occurrence in the project area.

The loggerhead sea turtle (threatened) is widely distributed in tropical and subtropical seas, occurring in the Atlantic Ocean from Nova Scotia to Argentina, the Gulf of Mexico, the Indian and Pacific oceans (although it is rare in the eastern and central Pacific), and the Mediterranean Sea (Iverson, 1986; Rebel, 1974; Ross, 1982). In the continental U.S., loggerhead sea turtles nest along the Atlantic coast from Florida to as far north as New Jersey (Musick, 1979) and sporadically along the Gulf coast, including Texas. Like the worldwide population, the population of loggerhead sea turtles in Texas has declined. The loggerhead is the most abundant turtle in Texas marine waters, preferring shallow inner continental shelf waters and occurring only very infrequently in the bays. It is often seen around offshore oil rig platforms, reefs, and jetties. Loggerhead sea turtles are probably present year-round but are most noticeable in the spring when one of their food items, the Portuguese man-o-war, is abundant. Loggerheads constitute a major portion of the dead or moribund turtles washed ashore (stranded) on the Texas coast each year. Most of these deaths are the result of accidental capture by shrimp trawlers, where caught turtles drown and their bodies dumped overboard. In 1999, two loggerhead sea turtle nests were confirmed in Texas, while in 2000, five loggerhead sea turtle nests were confirmed (Shaver, 2000). For the last 5 years, up to five loggerhead sea turtle nest per year have been recorded from the Texas coast (Shaver, 2006). Between 1996 and 2005, maintenance dredging in the Sabine Pass Entrance Channel by hopper dredges resulted in the lethal take of a loggerhead sea turtle in 2002 (Rob Hauch, pers. comm., 2006). The species is of potential occurrence in the project area.

The green sea turtle (threatened) is a circumglobal species in tropical and subtropical waters. In U.S. Atlantic waters, it occurs around the U.S. Virgin Islands, Puerto Rico, and continental U.S. from Massachusetts to Texas. Major nesting activity occurs on Ascension Island, Aves Island (Venezuela), Costa Rica, and in Surinam. Relatively small numbers nest in Florida, with even smaller numbers in Georgia, North Carolina, and Texas (Hirth, 1997; NMFS and USFWS, 1991a, 1991b). The green sea turtle in Texas inhabits shallow bays and estuaries where its principal foods, the various marine grasses, grow (Bartlett and Bartlett, 1999). While green sea turtles prefer to inhabit bays with seagrass meadows, they may also be found in bays that are devoid of seagrasses. The green sea turtles in these Texas bays are mainly small juveniles. Adults, juveniles, and even hatchlings are occasionally caught on trotlines or by offshore shrimpers or are washed ashore in a moribund condition. Green turtle nests are rare in Texas. Five nests were recorded at the Padre Island National Seashore in 1998, none in 1999, and one in 2000 (Shaver, 2000). For the last 5 years, up to five nests per year have been recorded from the Texas coast (Shaver, 2006). Since long migrations of green sea turtles from their nesting beaches to distant feedings grounds are well documented (Green, 1984; Meylan, 1982), the adult green sea turtles occurring in Texas may be either at their feeding grounds or in the process of migrating to or from their nesting beaches. The juveniles frequenting the seagrass meadows of the bay areas may remain there until they move to other feeding grounds or, perhaps, once having attained sexual maturity, return to their natal beaches outside of

Texas to nest. There are no records of green sea turtles nesting on Louisiana Point or anywhere in that area (Firmin, 2006), but documented records of green sea turtles exist from Jefferson County, Texas (Dixon, 2000). It is of potential occurrence in the project area.

The Texas horned lizard (State threatened) occurs throughout the western two-thirds of the state in a variety of habitats, but prefers arid to semiarid habitats in sandy loam or loamy sand soils that support patchy bunch-grasses, cacti, yucca, and various shrubs (Dixon, 2000; Henke and Fair, 1998). Dixon (2000) shows historic records from the study area; however, because of the limited terrestrial habitat, it is unlikely they would occur in the study area.

The Northern scarletsnake (State threatened) inhabits loose, sandy soil of pine, hardwood, and mixed forest environments as well as adjacent open, agricultural fields, swamps, and stream banks of extreme east Texas (Tennant, 1998). Dixon (2000) shows historic records from the study area; however, because of the limited terrestrial habitat, it is unlikely they would occur in the study area.

The timber rattlesnake (State threatened) typically inhabits dense thickets and brushy areas along the floodplains of major creeks and rivers throughout the eastern third of Texas. It occurs in a variety of habitats including floodplains and riparian areas, swamps, upland pine and deciduous woodlands, abandoned farmland, and limestone bluffs (Werler and Dixon, 2000). This rattlesnake is most active during the summer and fall, with some activity noted in spring and as late as December (Werler and Dixon, 2000). Documented records exist from Jefferson County, Texas (Dixon, 2000); however, it is unlikely the species would occur in the study area because of the lack of suitable habitat.

The alligator snapping turtle (State threatened) is the largest North American freshwater turtle species. Alligator snapping turtles inhabit deep rivers, lakes, and large streams of the southeastern U.S. (Garrett and Barker, 1987). Documented records exist from Jefferson and Rusk counties, Texas (Dixon, 2000), but the species is unlikely to occur in the study area because of the lack of suitable habitat.

3.12.3.5 Fish and Amphibians

The smalltooth sawfish (endangered) historically was common throughout the Gulf from Texas to Florida, and along the east coast from Florida to Cape Hatteras. The current range of this species has contracted to peninsular Florida, and smalltooth sawfish are relatively common only in the Everglades region at the southern tip of the state. Smalltooth sawfish are usually found in shallow (typically less than 33 feet), warm (water temperatures exceeding 61°F) coastal waters, close to shore, over muddy and sandy bottoms. The most recent verified report of a smalltooth sawfish from Texas waters was in 1998. Since the smalltooth sawfish prefer shallow water, it is unlikely they would be encountered in the project areas that would be dredged.

The Gulf sturgeon (threatened) historically ranged along the northeastern Gulf, in major rivers from the Mississippi delta in Louisiana, east to Charlotte Harbor, Florida, and in marine waters of the central and eastern Gulf (NMFS, 2006b; USFWS and Gulf States Marine Fisheries Commission [GSMFC], 1995). Its current range extends from Lake Pontchartrain and the Pearl River in Louisiana and Mississippi east to the Suwannee River in Florida. Sporadic records exist from as far west as the Rio Grande between Texas and Mexico, and as east and south as Florida Bay. As with other sturgeon species, the damming of rivers has been the most significant threat to the Gulf sturgeon (NMFS, 2006b). The study area is not within the known historic range of the Gulf sturgeon. Fish are mobile species and frequently occur outside of their normal ranges; however, it is unlikely that the species is present in the study area.

The dusky shark (SOC) is a large shark with a wide-ranging distribution in warm-temperate and tropical continental waters. It is coastal and pelagic in its distribution, where it occurs from the surf zone to well offshore. Habitat for this species does exist in the project area.

The sand tiger shark (SOC) has a broad inshore distribution. In the western Atlantic, this shark occurs from the Gulf of Maine to Florida, in the northern Gulf, in the Bahamas and in Bermuda. They are generally coastal, usually being found in the surf zone down to depths around 75 feet. They may also be found in shallow bays. They usually live near the bottom, but may be found throughout the water column. Their biggest threat is overfishing. Habitat for this species may exist in the project area.

The night shark (SOC) is a deepwater shark reported in waters from Delaware south to Brazil, including the Gulf. This shark is usually found at depths greater than 900 to 1,200 feet during the day and 600 feet at night. Habitat for this shark does not exist in the project area.

The saltmarsh topminnow (SOC) is endemic to the north-central coast of the Gulf from Galveston Bay eastward to western Florida. They tend to live in salt marshes and brackish water. This species requires shallow flooded marsh surfaces for breeding and feeding. Coastal erosion and loss of marsh is thought to be the greatest threat to this species. It is possible that this species occurs in the project area.

The Warsaw grouper (SOC) is a very large fish found in the deepwater reefs of the southeastern U.S. This fish ranges from North Carolina to the Florida Keys and throughout much of the Caribbean and Gulf to the northern coast of South America. This species inhabits deepwater reefs on the continental shelf break in waters 350 to 650 feet deep. Habitat for this species does not exist in the project area.

The speckled hind (SOC) inhabits warm, moderately deep waters from North Carolina to Cuba, including Bermuda, the Bahamas, and the Gulf. The preferred habitat is hard-bottom reefs in depths ranging from 150 to 300 feet. Habitat for this species does not exist in the project area.

3.12.3.6 Invertebrates

Elkhorn coral was listed as threatened on May 9, 2006 (71 FR 26852) and is found on coral reefs in southern Florida and the Bahamas, and throughout the Caribbean. Its northern limit is Biscayne National Park, Florida. This species is particularly susceptible to damage from sedimentation. Neither the project area nor the study area is located within the historical range for this species, nor does suitable habitat exist in the project vicinity.

Staghorn coral was listed as threatened on May 9, 2006 (71 FR 26852) and is found throughout the Florida Keys, the Bahamas, and the Caribbean islands. This coral occurs in the western Gulf, but it is absent from U.S. waters in the Gulf. Neither the project area nor the study area is located within the historical range for this species, nor does suitable habitat exist in the project vicinity.

Colonies of ivory tree coral (SOC) are found to depths of 500 feet on substrates of limestone rubble, low-relief limestone outcrops, and high-relief, steeply sloping prominences. The project area is not located within the historical range for this species, nor does suitable habitat exist in the project vicinity.

3.13 CULTURAL RESOURCES

Archival and historical research was conducted to develop a baseline level of knowledge for prehistoric and historic period cultural developments and to identify archeological and historical sites previously recorded in the SNWW project area. Among the research efforts, a review of published historical literature and previous archeological investigation reports yielded information useful for developing a general chronology of cultural developments across the region. Also, archeological reports and official site records maintained by State historic preservation offices in Texas and Louisiana were relied upon to identify previously recorded archeological and historical sites in the project area. Other sources of information included official industrial and agricultural census data as well as historical maps of the area prior to 1900 through 1955.

Cultural resources found in the project vicinity are generally of the following common types. Terrestrial prehistoric sites typically found in the SNWW CIP project vicinity consist of eroded or partially eroded prehistoric shell midden sites. The majority of shell middens are located along the main waterways, oxbows, and near the coast. Approximately 80 percent of these sites are comprised primarily of shells from the brackish-water clam (*Rangia cuneata*) mixed with sparse pottery shards and faunal food remains. Some sites located closer to the coast also contain shells from the eastern oyster. Historic terrestrial sites in the project vicinity are related primarily to Civil War military forts and outposts, although a few National Register structures such as the Sabine Pass Lighthouse and the Rainbow Bridge, are also present. The most typical marine sites in the project area are Civil War shipwrecks.

3.13.1 Prehistoric Chronology and Historic Context

3.13.1.1 Prehistoric Chronology

The prehistoric chronology of the Sabine Lake area is not well understood, as the area has received only limited testing (Aten, 1983). However, since the current project area is a part of the upper Texas coast, the three-phased chronological sequence that was developed for that region (Paleoindian to Archaic to Late Prehistoric) can be employed, with each transition marked by significant adaptations in technology and settlement patterns. Chronological designations are Before the Common Era (B.C.E.) and Common Era (C.E.) as per the *American Anthropological Association Style Guide* (2009).

Paleoindian (10,000 B.C.E. to 8000 B.C.E.) populations ranged over most of North America by the end of the Pleistocene. In the northern Gulf region, the Paleoindian culture is identified by the occurrence of large lanceolate, fluted projectile points. Typically, Paleoindian sites are considered to reflect low-density populations and hunter-gatherer subsistence strategies.

The Archaic period (6000 B.C.E. to C.E. 700) is typically subdivided into four components; the Early Archaic (6000 B.C.E. to 2500 B.C.E.), the Middle Archaic (2500 B.C.E. to 1000 B.C.E.), the Late Archaic (1000 B.C.E. to 300 B.C.E.), and the Transitional Archaic (300 B.C.E. to C.E. 700). Evidence of the Early Archaic is scarce along the upper Texas coast, due to either a decrease in human population or the lack of stratified excavations (Story et al., 1990).

Although there is a dearth of information on the Early Archaic along the upper Texas coast, other areas in North America have produced data pointing to a generalized hunting and gathering technology and a minimum band level social organization. Ricklis and Blum (1997) hypothesized that coastal sites were frequented during the winter months as part of a seasonal exploitation pattern.

Coastal sites and shell middens become more frequent during the Middle Archaic, expressing a unique subsistence activity. The Middle Archaic populations displayed a more involved method of seasonal exploitation, as documented by Voellinger (1990) at 41GV22. Evidence found at this site indicates early spring exploitation.

A hunting and gathering pattern of subsistence continued during the Late Archaic in Texas, with pre-Caddo sites marking the beginning of settled village life shortly after 500 B.C.E. in parts of East Texas, as well as a marked rise in bison exploitation as a game resource, as reflected in bison-kill sites in Central Texas.

The Transitional Archaic is marked by an increase in settlement sites, often having large burial mounds. Such sites mark the introduction of, and reliance upon, agriculture that leads to population growth and the emergence of social and political systems (Turner and Hester, 1985).

The Late Prehistoric period (C.E. 700 to C.E. 1600) is marked by the emergence of ceramics and terminates with European contact and interaction. While Aten (1983) has identified six chronological Late Prehistoric periods in the Galveston Bay area, he notes that the Sabine Lake area lacks sufficient controlled excavations to place it within this chronological sequence.

3.13.1.2 Historic Context

European interest in the coastal areas of Texas began almost as soon as the first Spanish explorers landed on the mainland of North America in 1513. Shortly thereafter, the Spanish crown began granting contracts to private investors to colonize and explore the new territory. One expedition led by a Spaniard Panfílo de Narváez ended in disaster. It is due to this unfortunate expedition that we have the earliest report of Europeans coming ashore in the vicinity of Sabine Pass (Weddle, 1985).

European activity in the region decreased over the next 100 years. It was not until the French explorer Rene Robert Cavalier, Sieur de La Salle entered Spanish territory in the northern Gulf in the late seventeenth century that the Spanish government hastened plans to colonize the area. The French continued to visit the region as they explored, established posts, and traded goods as far east as the Trinity River during the late 1600s and 1700s (Bolton, 1970). The early French and Spanish explorers relied on the Sabine and Neches rivers as their principal transportation route.

In 1763, Spain was given the Louisiana Territory by Louis XV of France; however, by 1802 the Spanish crown relinquished control of the Louisiana Territory back to France due to the territory's increasing demands on Spain's resources (Haggard, 1945). Less than 1 year later, Napoleon sold the territory to the United States.

With Louisiana in the hands of the U.S., Spain had a new problem at their border. The close proximity between Spanish and U.S. troops in the area of the Sabine River led to a great deal of tension and brought about an agreement between the two sides in 1806, whereby a strip of land was defined between the two countries that neither would rule. The land called the "Neutral Strip" extended between the Sabine River eastward to the Arroyo Hondo and from the Gulf to the 32nd parallel. The Neutral Strip was a wild ungoverned area open to smuggling, slave trade, and other criminal activity. The area also was the staging ground for military expeditions against Spanish Texas by ostensibly freelance organizations called filibusters (Haggard, 1945).

The Neutral Strip was abolished by the Adams-Onis Treaty of February 1821 whereby Spain relinquished its claims on the Sabine and Neches river area (Gibson et al., 1978). The treaty was ratified by the Mexican government that same year. Also in 1821, the Treaty of Cordova transferred Spanish Texas to the Republic of Mexico (Block, 1976). The land subsequently became a part of the Republic of Texas in 1836, at which time the Republic of Texas and the U.S. encouraged trade across the border formed by the Sabine River.

Goods were moved along the Sabine and Neches rivers as early as 1830 due to the economics of river versus overland transport (Chick, 1988). Settlement and economic use of the region increased from the early days of the Texas Republic through early statehood, and the rivers continued to be used as the primary transportation route until the Civil War.

After Texas's decision to secede from the Union on February 1, 1861, Sabine Pass became an important source of revenue and supplies for the Confederacy. Blockade-runners could operate virtually undetected out of Sabine Pass, shipping large amounts of cotton and other supplies to foreign markets and returning with coffee, sugar, munitions, and medical supplies. The U.S. recognized the importance of Sabine Pass to the Confederacy, and it soon became a focal point for the Union blockade of the Texas Gulf Coast.

Fearing a Union invasion during the Civil War, the citizens of Sabine Pass decided to build a fort to protect their town. Local residents, including many slaves, constructed a dirt and timber earthwork overlooking the Sabine River. On September 24, 1862, the fort was shelled by Union gunboats and severely damaged. The following March, Major Josephus S. Irvine determined that the site was no longer useful (Block, 1976).

A new fort, Fort Griffin, was constructed a few miles away. With 30 engineers and 500 slaves, Major Julius Kellersberg constructed a triangular fort on an eminence overlooking the Sabine River. The fort was named for the commander of the Twenty-first Texas Battalion, Colonel William H. Griffin (Block, 1976).

Located across Sabine Pass opposite Fort Griffin, the Sabine Pass Lighthouse, which began operation in 1857, was an ideal observation post for the Confederate forces during the Battle of Sabine Pass. In September 1863, four Union gunboats leading a strong amphibious invasion force attacked Fort Griffin. At the Battle of Sabine Pass, Lieutenant Richard Dowling and a 46-man garrison disabled two of the attacking vessels and scattered the remainder of the Union ships (Block, 1976).

The U.S. strengthened its position at Sabine Pass with the arrival of the USS *Hatteras* and became more aggressive in the autumn of 1862. Union vessels conducted raids into the region as far north as Beaumont on the Neches River, destroyed much of the town of Sabine Pass, and bombarded and forced the temporary abandonment of Fort Griffin at Sabine Pass using both sail and steam vessels (Francavigilia, 1998). In January 1863, the Confederate forces fought back when they burned and destroyed the USS *Dan* near the Sabine Pass Lighthouse and captured the Union Vessel USS *Morning Light* and the schooner *Velocity* off Sabine Pass using the cotton-clad side-wheel steamers *Josiah H. Bell* and *Uncle Ben* (Francaviglia, 1998; Hardison, 1998).

The standoff between the two forces culminated with the Battle of Sabine Pass in September 1863. Under the direction of Lieutenant Richard W. Dowling, a 45-minute battle resulted in a Confederate victory. Lieutenant Dowling and his 46 men captured two gunboats, the USS *Sachem* and the USS *Clifton* and 350 prisoners, with an additional 61 U.S. soldiers and sailors missing or killed. Without losing a man, Dowling and the Guards prevented an invasion of Texas. The location of this battle is now preserved as the Sabine Pass Battleground and Historic Site (41JF36). A bronze statue of Dowling overlooks the 57.5-acre park.

The U.S. failed to establish itself in Texas during the war; however, the Union blockade did hinder the growth of burgeoning port cities in the state and all but decimated the economy of Sabine Pass for years to come (McGuff and Roberson, 1974).

3.13.2 Previous Investigations

3.13.2.1 Terrestrial Investigations and Recorded Sites

During 1939 and 1940, Gus Arnold of the University of Texas at Austin conducted an archeological survey in the region as a part of a larger east Texas study sponsored by the Works Progress Administration (Im, 1975). Arnold identified 28 sites within the project vicinity. Unfortunately, Arnold never published his results and the only record of his work exists as a Master of Arts thesis from the

University of Texas (Im, 1975). In this thesis, Im presents each site's general location, a short description, temporal components found, and a brief description of the artifacts (Im, 1975). Im noted the similarities between the ceramic artifacts collected by Arnold and those from the Lower Mississippi Valley and "supposed" (Im, 1975) that there were Mississippi Valley sherds among Arnold's collection. However, Im was not able to separate the Lower Valley sherds out of the collection, having particular difficulty in separating sherds dating to the Plaquemine and Coles Creek periods. Im concluded by noting that it seemed that sandy paste sherds occur more frequently early in the chronology and grog-tempered sherds later. Furthermore, he identified two culture areas in east Texas that he termed Caddoan and non-Caddoan with a boundary between the two areas located approximately 80 to 100 miles from the Gulf coast (Im, 1975).

After Arnold, McIntire (1958) recorded several sites in west Louisiana, and then used these sites to extend the Red River Chronology into that part of the state. In the late 1960s, Lawrence Aten and Charles Bollich undertook a survey in the Sabine Lake area of Louisiana and Texas (Aten and Bollich, 1969). Of the 14 sites visited by Aten and Bollich, four are within the project vicinity. Aten and Bollich (1969) attempted to order their ceramic artifacts by paste type (sandy paste and grog-tempered) with the assumption that sandy paste sherds would dominate the earlier assemblages. The authors (1969:Figure 4) concluded that both paste categories existed throughout the history of pottery making in the area with sandy paste sherds being a bit more numerous early in the sequence.

In 1973, the Texas Archeological Survey conducted an archeological survey along the Sabine and Neches rivers for the USACE (McGuff and Roberson, 1974). They visited 81 sites, 61 of which are located near the project area. McGuff and Roberson (1974) provided information on site description, condition, and impacts. Of the 81 sites visited, McGuff and Roberson (1974) listed 21 as potentially eligible for the National Register of Historic Places (NRHP).

In 1978, the USACE, Fort Worth District, sponsored two surveys of the lower Sabine River. The University of Southwestern Louisiana (now University of Louisiana, Lafayette) Center for Archeological Studies inventoried sites along the Sabine River from Toledo Bend Reservoir to the GIWW (Gibson, 1978). Gibson visited 12 sites in the project vicinity and determined that 10 of the sites were potentially eligible for National Register listing. In conjunction with the Gibson study, the University of New Orleans Archeological and Cultural Research Program inventoried sites along the Sabine River and its tributaries from the GIWW south to the Gulf (Beavers, 1978). Forty-two sites were visited by Beavers (1978), 19 of which are located in the project vicinity that he recommended for additional work.

The most recent archeological inventory was conducted by the Brazos Valley Research Associates for the City of Beaumont's Colliers Ferry Wetlands and Recreational Area and Nature Preserve (Moore and Aronow, 1993). No cultural resources were located during this survey, although they do discuss site 41JF1, which they noted was covered by 2 to 3 feet of dredged deposits.

While there has been a substantial amount of cultural resources inventory work done in the project area, there has been a distinct lack of more-detailed investigations involving archeological test excavations.

Several sites in the project vicinity have been subjected to some minimal level of formal testing: 41JF26, 41JF31 (Aten, 1983); 41OR58 (Rogers, 1991); 41CM141 (Servello and Blanchard, 1992); and 41JF11 and 41JF35 (Raab and Smith, 1983). Excavations were either limited to National Register eligibility testing or were not formally reported. The one site where extensive excavation has taken place is the Gaulding site (41JF27), excavated by the Texas Archeological Society (Aten and Bollich, 2002).

In addition to these traditional types of terrestrial archeological investigations, recent geological and remote-sensing investigations of submerged landforms located offshore have suggested that older prehistoric sites may have survived despite long-term inundation and sea level changes in the submerged relict Sabine River valley. A study by the MMS (Stright, 1990) located two possible *Rangia* midden sites approximately 16 miles offshore of the Louisiana/Texas border in the Gulf. Stright's work appears to confirm predictions published by Coastal Environments, Inc. (Pearson et al., 1986) that intact archeological sites may be located along relict tributaries associated with the now submerged Sabine River Valley.

3.13.2.2 Marine Investigations and Reported Shipwrecks

Several previous marine archeological investigations have occurred on the SNWW. Of these, four reports are pertinent to the current project. The four investigations discussed here are Bond and Foster (1993), Hoyt and Schmidt (1997), and Hoyt et al. (1994, 1998).

EH&A conducted a magnetometer survey on the lower Neches River in 1992 (Bond and Foster, 1993). Work was conducted under USACE permit number 19611 for the LNVA to identify possible shipwrecks at four potential saltwater barrier locations. Several magnetic anomalies were recorded during this survey, none of which were recommended as potential historic properties.

EH&A performed a remote-sensing survey of the Sabine Pass Channel and an assessment of the American Civil War–era shipwreck the USS *Clifton* (41JF65) under contract with the USACE in 1994 (Hoyt et al., 1994). Work was conducted in order to identify historic properties that might have been adversely affected by the USACE maintenance-dredging program and to locate and assess the wreck of the *Clifton*. EH&A was tasked with determining its potential for impacts during future jetty maintenance and repair activities (Hoyt et al., 1994). The remote-sensing survey recorded 26 localities that were recommended for diver investigation to identify whether they were historic shipwrecks. The report concluded that the wreck of the *Clifton* was eligible for listing in the NRHP. Further field investigations of the wreck, in the form of remote-sensing investigations and/or archeological excavation, were recommended should it be threatened by future projects.

EH&A followed up its 1994 work in the Sabine Pass Channel with diving assessments of the 26 localities identified in the previous work (Hoyt and Schmidt, 1997). This work was conducted in 1996 under contract with the USACE to determine whether the 26 localities were potential cultural resources. EH&A determined that 15 localities contained modern construction debris; 4 localities, although unidentified, were small and/or deeply buried objects not indicative of shipwrecks; 4 localities had been displaced or removed from the study area; 1 locality was located outside the impact area and within a previously dredged area and therefore likely was modern in origin; and 2 (L25 and L26) remained unidentified and not fully investigated. The latter were located in an area where project dredging had been completed and therefore were not recommended for further investigation. However, EH&A recommended that additional investigations be conducted, should future plans include channel widening at this location, due in part to the localities' possible association with a recorded American Civil War shipwreck in the area.

EH&A conducted archival research, a remote-sensing survey, and a terrestrial survey in 1997 for the USACE (Hoyt et al., 1998). Work was conducted to identify possible cultural resources at a proposed site for the Neches River Saltwater Barrier, north of Beaumont in the vicinity of Pine Island Bayou. Archival research identified a single historic structure in the study area, a navigation light, which was not physically located during the survey. Numerous magnetic anomalies and side-scan sonar images were recorded during the remote-sensing survey. None of these anomalies was identified as possible cultural resources, and further archeological investigations were not recommended.

As part of the marine investigation, PBS&J researched several databases and secondary sources in order to produce a list of shipwrecks, archeologically sensitive areas, State Archeological Landmark (SAL) and NRHP sites potentially located within the study area. Such sources include PBS&J's shipwreck database, the shipwreck files at the Texas Historical Commission's (THC) Office of the State Marine Archeologist, the shipwreck files at the Louisiana Division of Archaeology (LDA), the NOAA Automated Wreck and Obstruction Information System, the MMS shipwreck database, the GLO's Resource Management Codes, the NPS's NRHP listings, the THC's SAL listings, and the THC's Historical Marker Program. In addition to these databases, cartographic resources such as NOAA's historical and modern navigation charts were useful in identifying possible shipwreck locations. Additional secondary sources such as Lytle and Holdcamper's (1975) Merchant Steam Vessels of the United States and the United States Bureau of Navigation's (various years) Merchant Vessel Losses of the United States were important sources for identifying historic and modern vessel losses.

PBS&J conducted a marine remote-sensing survey for the current FEIS along portions of the SNWW in Jefferson and Orange counties, Texas, and Cameron Parish, Louisiana, throughout February 2003. The survey covered the Outer Bar Channel, the Sabine Pass Jetty Channel, the Sabine Pass Channel, the Port Arthur Canal, the Sabine-Neches Canal, and the Neches River Channel. The survey included the assessment of potential historic properties, oyster reefs, pipelines and wells, and potential obstructions to navigation in the survey area. PBS&J's survey identified 27 potential historic properties, of which 15 would be impacted by the proposed project. Two previously recorded magnetic anomalies, L25 and L26 (Hoyt and Schmidt, 1997), were also identified as potential shipwrecks. PBS&J recommended that all 27 potential historic properties be avoided by bottom-disturbing activities. Anomalies for which avoidance is not feasible were recommended for further archeological investigations in the form of close-order remote-sensing surveys to aid differentiation between anomalies requiring diver assessment and anomalies associated with debris.

The results of the remote-sensing survey can be found in the report titled, *Historic Properties Identification, Oyster Reef Identification, and Pipeline and Obstruction Identification for the Sabine/*

Neches Waterway Widening and Deepening, Jefferson and Orange Counties, Texas, and Cameron Parish, Louisiana, prepared for the USACE by PBS&J dated September 2005 (Enright and Gearhart, 2005). Project plans have been modified since the study was conducted. The 27 anomalies located during the February 2003 survey are included on the current project plans.

The density of reported shipwrecks increases at the northwest corner of Sabine Lake where the SNWW divides near the mouth of the Neches River and Stewts Island. Farther up the Neches River, reported shipwrecks are present near Deer Bayou, Smith Bluff Cutoff, and Bethlehem Steel in Beaumont. In addition to these shipwrecks, the National Defense Reserve Fleet maintains a reserve of vessels on the Neches River near Beaumont that can be activated to help meet U.S. shipping requirements during a national emergency. Many are mothballed World War II naval vessels moved from the Reserve Naval Station Orange facility. This large fleet of intact and floating naval vessels may also extend into the old river channel that was cut off at Smith Bluff. Although not technically shipwrecks, many of these vessels are of sufficient age to meet NRHP eligibility requirements and may represent important World War II–era military developments associated with the study area.

A high density of reported shipwrecks is present in Sabine Pass. Sabine Pass and the adjacent Gulf coast are deemed to be archeologically sensitive in regards to the potential for historic shipwrecks, some of which include the CSS *Clifton*, three steam-driven vessels (*Pearl Plant*, USS *Dan*, and CSS *Sachem*), three sail-driven vessels (schooners *Manhassett* and *Revenge* and USS *Morning Light*), as well as an unknown quantity of jettisoned cargo lost in the area during the American Civil War. Sabine Pass is also home to the Sabine Pass Lighthouse, which is listed on the NRHP.

No remote-sensing survey has been conducted for the Sabine Bank Channel, the proposed Extension Channel, or the existing or proposed ODMDSs. The USACE researched the MMS files on known and potential historic shipwrecks in the Gulf portion of the SNWW project area. The MMS locations are only approximate because many wreck locations cannot be determined with certainty and are reported by lease block only. The approach corridor to Sabine Pass is a high probability area for shipwrecks. Numerous shipwrecks have been documented in the area including vessels that participated in the Battle of Sabine Pass during the American Civil War. Several shipwrecks have been reported in the vicinity of these anomalies, including *Terry Walker*, *Beulah*, *Esther*, *Kile No. 1*, *L.A. Burnham*, and one unidentified wreck (u128). Other wrecks reported in the general vicinity of the Outer Bar Channel include *Ella*, *Hattie*, *John Sealy*, *Manhassett*, USS *Morning Light*, and *Revenge*.

3.13.2.3 National Register Properties

There are two sites listed on the NRHP that are located adjacent to the proposed SNWW CIP: Rainbow Bridge and the Sabine Pass Lighthouse. Rainbow Bridge is the cantilever bridge crossing the Neches River just upstream from Sabine Lake. It allows SH 87 and SH 73 to connect Port Arthur with Bridge City. The Sabine Pass Lighthouse was described above. There is also one SAL (site 41JF65, the USS *Clifton*), also discussed above, that is located adjacent to the proposed SNWW CIP.

3.14 SOCIOECONOMIC RESOURCES

3.14.1 Introduction

This section presents detailed economic and demographic characteristics of the study area. Information evaluated within this section includes population, demographic, and community cohesion factors, employment, labor force characteristics, economics, tax base, land use, transportation, community services, aesthetics, future development and development restrictions, life, health, and safety, and Environmental Justice (EJ).

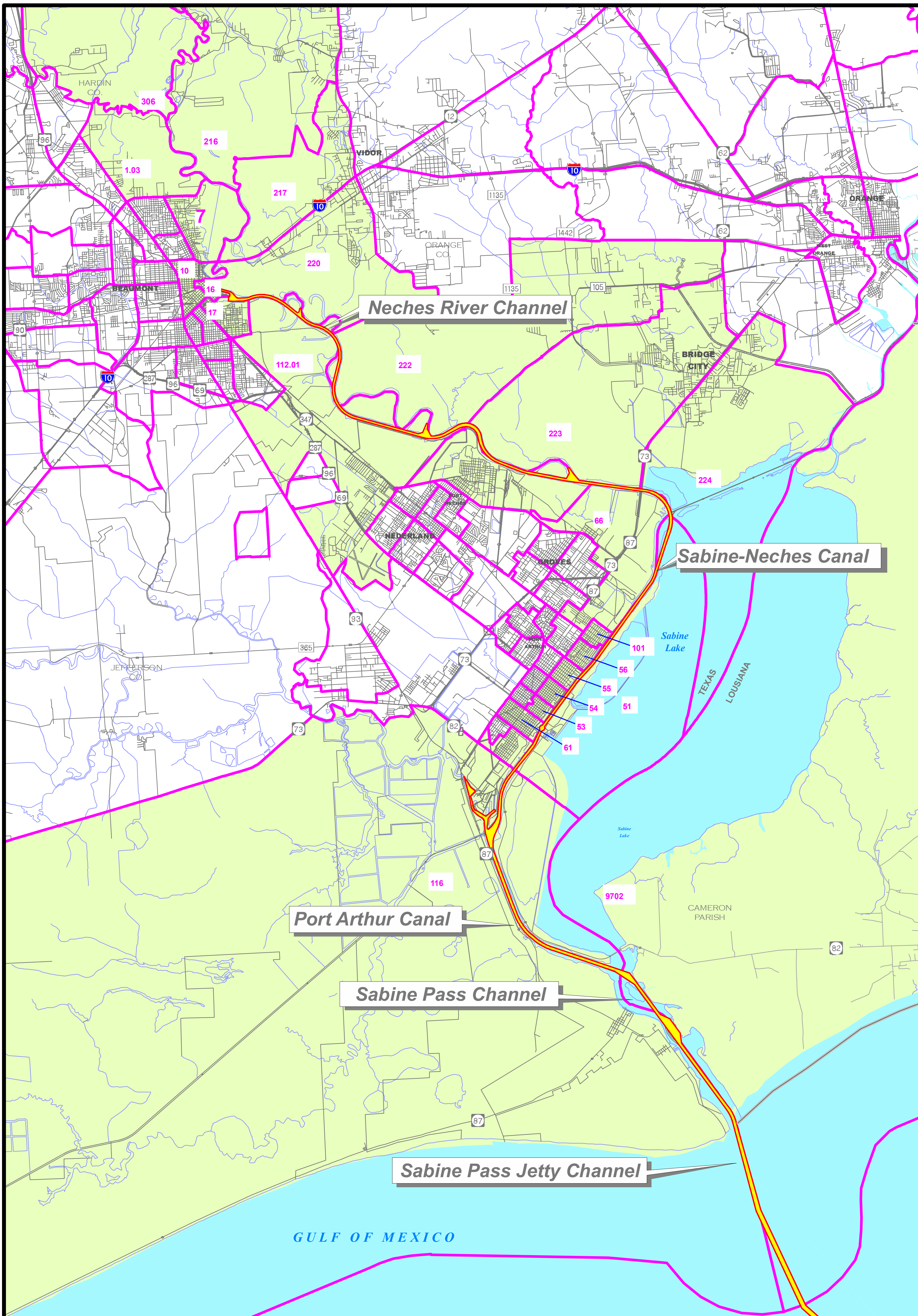
Two geographic levels have been selected to analyze the socioeconomic components of the proposed study area. These two levels have been chosen to capture more fully the socioeconomic setting and its relationship to the regional economy. These two geographic levels are the study area and the detailed study area.

3.14.1.1 Study Area

For the purposes of this section, the following counties and parishes are used as units of socioeconomic analysis: Hardin, Jefferson, and Orange counties in Texas, and Cameron and Calcasieu parishes in Louisiana. Also the following cities are discussed: Beaumont, Port Arthur, Port Neches, Nederland, Vidor, Orange, and Bridge City in Texas; and Lake Charles in Louisiana. Also, census data and other socioeconomic data are provided for the BPA Metropolitan Statistical Area (MSA) (includes Hardin, Jefferson, and Orange counties, Texas), although some portions of these MSAs are not part of the study area. The Lake Charles MSA is the only other MSA within the study area, but it is not included because it includes only Calcasieu Parish (which is already discussed). Also, wherever it was possible, the Texas portion of the study area, and the Louisiana portion of the study area are discussed. In such cases, socioeconomic data are provided separately for all Texas counties and for all Louisiana parishes. Finally, some communities within the study area are discussed in more detail than others simply because they are located closer to areas affected by the proposed project, or areas near to the detailed study area, which is the second geographic level of analysis (below).

3.14.1.2 Detailed Study Area

The detailed study area for this section is defined differently than for other sections of this FEIS. The detailed study area, for this section, includes only census tracts that are within (or at least partially overlap into) the “detailed study area” that is shown on Figure 3.14-1 (2000 census tracts). The detailed study area, as defined within this section only, includes areas within a 1-mile-wide corridor of the areas proposed for ship channel improvements. Many of the census tracts included in this section overlap partly into the detailed study area, but cover much larger areas outside of the detailed study area. Therefore, the census data (provided by census tract) for the detailed study area include much larger populations than those that physically live within the detailed study area (areas included in the census tract level analysis are shaded yellow). These areas include incorporated areas of Beaumont, Port Neches, Nederland, Bridge City, and Port Arthur and unincorporated areas within Jefferson, Hardin, and Orange counties, Texas, and



N
W E
S

16,500 8,250 0 16,500 Feet

Source: TIGER Census 2000 data.

102 Census Tract Number

Census Tracts within the Main Channel Corridor

Project Area, Proposed Channel

Figure 3.14-1

2000 Census Tracts Sabine-Neches Waterway

Prepared for: USACE Galveston	
Job No: 100007609	Scale: 1" = 16500'
Prepared by: 18895	Date: 07/9/2009
N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Census_2000_11_17_vr4.mxd	

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Cameron Parish, Louisiana. Finally, the census tract figure breaks up the detailed study area into the following subcategories based on the names of different segments of the ship channel (from north to south): Neches Channel, Sabine-Neches Channel, Port Arthur Channel, Sabine Pass Channel, and the Sabine Pass Jetty Channel.

3.14.2 Population and Community Cohesion

3.14.2.1 Historic and Projected Population

Table 3.14-1 presents the current and historic population data for the study area. From 1980 to 1990, population growth within the study area was negative, with only a few communities exhibiting positive population growth during the 1980s. Negative population growth in the study area during the 1980s is largely attributable to high unemployment rates, and economic problems within the region due to the 1980s "oil bust," when manufacturing and construction industries within the study area (and other locations in Texas and Louisiana) suffered heavy economic losses and layoffs (Helen, 2002). During the 1980s the study area cities with the greatest population growth were Bridge City (6.5 percent increase) and Nederland (0.0 percent growth), while the greatest decreases in population were experienced in the City of Orange (at negative 12.9 percent) and Port Arthur (at negative 7.6 percent). Among study area counties and parishes, the greatest population growth during the 1980s occurred in Hardin County (at 1.5 percent growth) and Calcasieu Parish (at 0.5 percent growth), while the greatest decreases in population occurred in Jefferson County (at negative 4.6 percent) and in Orange County (at negative 4.0 percent). The population changes within the study area during the 1980s contrasted sharply with that of the State of Texas (at 19.4 percent), while it was fairly consistent with that of the State of Louisiana (at 0.3 percent) during this period. A possible reason for this trend is that the Texas economy, during the 1980s, was more diverse overall than the study area economy and that of the State of Louisiana, and therefore unemployment rates and economic losses were not as high, and out-migration of the population was not as prevalent.

Between 1990 and 2000 the study area population became positive again, with slow to moderate population growth (at 7.4 percent) occurring during this period. During the 1990s (especially during the late 1990s), the national economy had greatly improved, and within the study area less out-migration of population was occurring, as manufacturing and construction sectors were experiencing a partial recovery from the economic problems they had experienced during the 1980s. These sectors were retaining more of their employees, and the services sector was expanding, especially along the IH 10 corridor (Helen, 2002). During the 1990s the study area cities with the greatest population growth were Bridge City (6.0 percent increase) and Nederland (3.3 percent growth), while the greatest decreases in population were experienced in Orange (at negative 9.4 percent) and Port Arthur (at negative 0.9 percent). Among study area counties and parishes, the greatest population growth during the 1990s occurred in Hardin County (at 16.3 percent growth) and Calcasieu Parish (at 9.2 percent growth), while the slowest population growth occurred in Jefferson County (at 5.3 percent) and in Orange County (at 5.5 percent). The population changes within the study area during the 1990s contrasted sharply with that of the State of Texas (at 22.8 percent), while it was fairly consistent with that of the State of Louisiana (at 5.9 percent) during this period. Much of this trend is attributable to the diversification of the study area economy relative to that of the states of Texas and Louisiana. The Texas economy was more diverse overall and was booming in the communications, high-tech, and services industries overall, and the population was expanding as a result. These trends were not occurring in the study area or the State of Louisiana to nearly the same degree.

Table 3.14-1
Study Area Population Trends, 1980–2000

Place	Population			Percent Change		
	1980	1990	2000	1980–1990	1990–2000	1980–2000
Beaumont	118,102	114,323	113,866	–3.2	–0.4	–3.6
Bridge City	7,667	8,164	8,651	6.5	6.0	12.8
Lake Charles	75,226	70,508	71,757	–6.3	1.8	–4.6
Nederland	16,855	16,858	17,422	0.0	3.3	3.4
Orange	23,628	20,571	18,643	–12.9	–9.4	–21.1
Port Arthur	63,053	58,274	57,755	–7.6	–0.9	–8.4
Port Neches	13,944	13,615	13,601	–2.4	–0.1	–2.5
Vidor	12,043	11,385	11,660	–5.5	2.4	–3.2
Hardin County	40,721	41,320	48,073	1.5	16.3	18.1
Jefferson County	250,938	239,397	252,051	–4.6	5.3	0.4
Orange County	83,838	80,509	84,966	–4.0	5.5	1.3
Calcasieu Parish	167,223	168,134	183,577	0.5	9.2	9.8
Cameron Parish	9,336	9,260	9,991	–0.8	7.9	7.0
Beaumont-Port Arthur MSA	**375,497**	**361,218**	**385,090**	**–3.8**	**6.6**	**2.6**
Lake Charles MSA	**167,223**	**168,134**	**183,577**	**0.5**	**9.2**	**9.8**
State of Louisiana	**4,205,900**	**4,219,973**	**4,468,976**	**0.3**	**5.9**	**6.3**
State of Texas	**14,229,191**	**16,986,510**	**20,851,820**	**19.4**	**22.8**	**46.5**
Project Study Area*	**552,056**	**538,612**	**578,658**	**–2.4**	**7.4**	**4.8**

Source: U.S. Census Bureau (1990, 2000a).

*The Project Study Area population is calculated from a combined total of the Beaumont-Port Arthur MSA, the Lake Charles MSA, and Cameron Parish.

Table 3.14-2 provides population projections from 2000 to 2050 for Hardin, Jefferson, and Orange counties, Texas, and Calcasieu and Cameron parishes, Louisiana, the State of Texas, and the State of Louisiana. Generally, population within the study area counties and parishes is expected to be slow to moderate through year 2050.[1] The greatest population growth rates within the study area during this period are anticipated in Hardin County (average decade growth rate of 8.1 percent). The slowest population growth rates during this period are anticipated in Cameron Parish (average decade growth rate of negative 16.3 percent) and in Orange County (average decade growth rate of 3.3 percent).

[1]Population projections for Calcasieu and Cameron parishes and the State of Louisiana for the years 2030 to 2050 were not available from the Louisiana State Data Center. Therefore, projections were made for these years based on average increases in population from the preceding 3 decades (for which projections were available). The average rate of growth that was used for these 3 decades for Calcasieu and Cameron parishes and the State of Louisiana were 5.7 percent, 1.3 percent, and 5.8 percent, respectively, for each decade from 2020 to 2050.

Table 3.14-2
Detailed Study Area Population Projections, 2000–2050

							Percent Change				
Place	2000	2010	2020	2030	2040	2050	2000–2010	2010–2020	2020–2030	2030–2040	2040–2050
Hardin County	48,073	54,504	59,115	61,211	63,381	65,627	13.4%	8.5%	3.5%	3.5%	3.5%
Jefferson County	252,051	259,700	270,686	280,590	288,225	295,924	3.0%	4.2%	3.7%	2.7%	2.7%
Orange County	84,966	90,503	94,274	95,818	96,473	97,843	6.5%	4.2%	1.6%	0.7%	1.4%
State of Texas	20,851,790	24,915,388	29,117,537	33,052,506	36,893,267	41,071,409	19.5%	16.9%	13.5%	11.6%	11.3%
Calcasieu Parish	183,577	85,400	183,740	197,420	NA	NA	1.0%	-0.9%	-2.4%	NA	NA
Cameron Parish	9,991	7,230	6,660	5,760	NA	NA	-27.6%	-7.9%	-13.5%	NA	NA
State of Louisiana	4,424,550	4,683,030	4,991,410	5,360,774	NA	NA	5.8%	6.6%	7.4%	NA	NA

Sources: TWDB (2007); Louisiana State Census Data Center (2007).

There are a few factors that are likely to contribute to the slow to moderate population growth that is projected for the project study area from 2000 to 2050 (see Table 3.14-2). The population projections are based on socioeconomic trends in the last 30 years or so, which are likely to continue in the future. Namely, the study area's economy has grown at a slow to moderate rate over the past 2 decades, since the "oil bust" of the 1980s. During the 1980s, the study area's population growth was negative, as the manufacturing sector lost about 17,000 jobs, and many residents left the area to find better opportunities elsewhere. During the 1990s, the economic situation improved somewhat, but not enough to fully recover from major job losses in the 1980s. Population growth during the 1990s was slow to moderate in all communities of the study area, largely as a response to these economic trends. Population growth has been slow even as many large cities in Texas had booming economies during the late 1990s. Job growth occurred in the services, wholesale and retail trade, government, and medical services industries within the study area during this period, but not enough to offset lagging job growth in the manufacturing industry. Housing units were added at a relatively steady rate, but the average household size got smaller during the decade, so that the new housing units were not an indicator of rapid population growth. Many manufacturing companies upgraded or expanded their facilities, but with these improvements came mechanization of jobs, and this led to little growth in new jobs. Therefore, the study area economy has seen very few economic indicators that the economy is going to grow at a rate that is any different than what has occurred in the recent past. Without such growth in new jobs, it is unlikely that the study area population is going to grow any faster than slow to moderate, as it has done in the recent past. Without any economic indicators showing otherwise, analysts with the TWDB, and locally based population analysts believe that population growth within the study area would continue to be slow to moderate from 2000 to 2050 (Helen, 2002). Table 3.14-3 provides population figures for 2000 for the detailed study area. The total detailed study area population was 82,401 in 2000.

3.14.2.2 Demographics and Community Cohesion Factors

Being an intangible concept, the definition and, therefore, the measurement of community cohesion is not precise. There are certain factors, however, that can be measured and that can be interpreted to reflect community cohesion. The following community cohesion factors are presented within this section:

- Education and income
- Travel time to work
- Length of residence
- Degree of home ownership
- Age distribution

Table 3.14-3
Detailed Study Area Population, 2000

Census Tracts	2000 Population
Hardin County, Texas	
306	3,116
Jefferson County, Texas	
1.03	3,084
7	3779
10	1,739
16	104
17	2,776
51	1,689
53	1,154
54	2,053
55	3,352
56	3,893
61	2,139
66	4,905
101	3,287
108	5,210
112.01	7,175
116	2,307
Orange County, Texas	
216	3,929
217	2,623
220	4,082
222	3,027
223	6,475
224	5,950
Cameron Parish, Louisiana	
9702	4,553
Total Detailed Study Area Population:	82,401

Source: U.S. Census Bureau (2000a).

Education and Income. Table 3.14-4 shows educational attainment levels for detailed study area census tracts (2000), and provides a comparison with state, county and parish figures. In terms of higher education (bachelor's degrees and graduate or professional degrees), the highest levels of educational attainment in the study area are found in Calcasieu Parish (at 16.9 percent) and the lowest levels of educational attainment are found in Cameron Parish (at 7.9 percent). In terms of high school education, the highest levels of educational attainment in the study area are found in Hardin County (at 79.3 percent), and the lowest level of educational attainment is found in Cameron Parish (at 68.1 percent). The average of the detailed study area census tracts' highest educational levels attained are as follows: high school graduate (80.6 percent), bachelor's degree (6.6 percent), and graduate or professional degree (2.3 percent). In terms of high school education, the detailed study area was consistent with study area

Table 3.14-4
Detailed Study Area Educational Attainment, 2000

Study Area Census Tracts	Percent of Persons 25 Years and Older					
	High School Graduate		Bachelor's Degree		Graduate or Professional Degree	
Hardin County						
306	801	79.3%	170	8.5%	62	3.1%
Jefferson County						
1.03	547	73.8%	51	3.5%	38	2.6%
7	689	64.4%	82	3.9%	18	0.9%
10	336	51.6%	26	2.3%	16	0.4%
16	22	88.2%	21	27.6%	10	3.2%
17	719	66.0%	49	2.6%	3	1.6%
51	390	71.9%	70	5.9%	25	2.1%
53	223	57.8%	35	4.9%	0	0.0%
54	485	62.4%	21	1.7%	24	2.0%
55	587	62.7%	128	6.7%	54	2.8%
56	575	56.7%	96	4.8%	19	0.9%
61	568	57.8%	34	2.3%	0	0.0%
66	934	65.3%	102	4.1%	22	0.9%
101	597	67.7%	105	6.0%	39	2.2%
108	1,236	84.6%	413	12.5%	102	3.1%
112.01	1,566	84.3%	528	11.4%	292	6.3%
116	627	76.7%	160	10.6%	32	2.1%
Orange County						
216	1,055	70.2%	139	5.6%	42	1.7%
217	721	72.5%	69	4.1%	22	1.3%
220	992	70.7%	70	2.8%	37	1.5%
222	777	83.5%	168	8.9%	63	3.4%
223	1,531	85.3%	359	8.6%	129	3.1%
224	1,277	80.5%	256	6.9%	54	1.4%
Cameron Parish						
9702	1,138	62.4%	140	4.8%	65	2.2%
Detailed Study Area Total/Average	18,393	80.6%	3,292	6.6%	1,168	2.3%
Hardin County, Texas	12,380	79.5%	2,972	9.7%	1,027	3.3%
Jefferson County, Texas	53,421	78.5%	18,477	11.5%	7,786	4.8%
Orange County, Texas	21,012	79.0%	4,450	8.2%	1,506	2.8%
Total Texas Study Area Counties	86,813	84.8%	25,899	9.8%	10,319	3.6%
Cameron Parish, Louisiana	2,677	68.1%	338	5.4%	158	2.5%
Calcasieu Parish, Louisiana	39,616	77.0%	13,280	11.6%	6,037	5.3%
Total Louisiana Study Area Parishes	42,293	80.0%	13,618	8.5%	6,195	3.9%
State of Louisiana	899,354	74.8%	339,711	12.2%	180,067	6.5%
State of Texas	3,176,743	75.7%	1,996,250	15.6%	976,043	7.6%

Source: U.S. Census Bureau (2000b).

county and parish attainment levels, and higher than the State of Louisiana and the State of Texas. In terms of higher education, the detailed study area was relatively low as compared with study area county and parish attainment levels, and very low when compared with the State of Texas and the State of Louisiana. Considering the Texas and Louisiana portions of the study area (the total/average for the counties/parishes for each respective state within the study area), the 2000 Census data show that the Louisiana portion of the study area (at 12.4 percent) has a slightly lower level of educational attainment in terms of higher education when compared with the Texas portion of the study area (at 13.4 percent). In terms of high school education, the levels of educational attainment for the Texas and Louisiana portions of the study area are 84.8 and 80.0 percent, respectively.

Table 3.14-5 provides the 1999 median family income for detailed study area census tracts and provides a comparison with county, parish, and state figures. The highest median family income within the study area is found in Hardin County (at $37,612), while the lowest median family income is found in Cameron Parish (at $34,232). All of the median family income figures for study area counties and parishes are higher than that of Louisiana (at $32,566), and lower than that of Texas (at $39,927). The detailed study area (average) median family income is $28,884, which is substantially lower than the State of Texas, and study area counties and parishes, and lower than the State of Louisiana. The detailed study area census tracts with the highest median family income were Orange County tract 223 (at $48,586) and tract 222 (at $46,474), while the lowest median family incomes were found in Jefferson County tracts 16 (at $11,833) and tract 53 (at $13,803). Within the Texas and Louisiana portions of the study area, the Texas portion had a higher median household income (at $36,635) than the Louisiana portion of the study area (at $34,802).

Travel Time to Work. Table 3.14-6 provides 2000 average travel time to work data for the detailed study area census tracts and provides a comparison with county, parish, and state figures. The longest average travel time to work is found in Hardin County (at 29.2 minutes), while the shortest average travel time to work is found in Jefferson County (at 19.9 minutes). The average travel time to work for the detailed study area is 21.5 minutes, which is relatively low when compared with the study area counties and parishes, and is lower than both Texas and Louisiana. The detailed study area census tracts with the shortest travel time to work were Jefferson County tracts 16 (at 12.1 minutes) and 53 (at 15.1 minutes). The longest travel times to work were found in Jefferson County tracts 10 (at 28.4 minutes) and 116 (at 27.4 minutes). Commute times within the Texas portion of the study area are only slightly longer (at 23.6 minutes) than in the Louisiana portion of the study area (at 22.7 minutes).

Generally speaking, the prevailing movement of commuters is from study area suburbs towards Beaumont and Port Arthur, and to industrial employment centers in Bridge City and Orange. Major employers draw the largest number of commuters, and these are concentrated primarily along the ship channels within the study area. One major commuter movement is from Hardin County, south along SH 96/69/287 towards Beaumont in the morning, and returning northward from Beaumont to Hardin County in the afternoon. Also, in the mornings many of these commuters continue to travel south along SH 96/69/287 towards the Port Arthur area and employment locations along the ship channel, and return

Table 3.14-5
Detailed Study Area Median Family Income, 1999

Place/2000 Census Tract	Median Family Income $ (1999)
Hardin County	
306	35,727
Jefferson County	
1.03	18,393
7	17,409
10	17,225
16	11,833
17	22,500
51	16,393
53	13,803
54	18,711
55	27,719
56	32,845
61	16,449
66	20,177
101	29,792
108	41,890
112.01	45,789
116	39,868
Orange County	
216	39,728
217	30,476
220	30,599
222	46,474
223	48,586
224	38,254
Cameron Parish	
9702	32,575
Detailed Study Area Average	28,884
Hardin County, Texas	37,612
Jefferson County, Texas	34,706
Orange County, Texas	37,586
Average of Texas Counties	36,635
Cameron Parish, Louisiana	34,232
Calcasieu Parish, Louisiana	35,372
Average of Louisiana Parishes	34,802
State of Louisiana	32,566
State of Texas	39,927

Source: U.S. Census Bureau (2000c).

Table 3.14-6
Detailed Study Area Travel Time to Work, 2000

Place/Census Tracts	Aggregate Travel Time (minutes)	Total Workers (16+ years old)	Average Travel Time (minutes)
Hardin County			
306	36,385	1,408	25.8
Jefferson County			
1.03	18,790	1,012	18.6
7	29,300	1,104	26.5
10	17,120	602	28.4
16	255	21	12.1
17	21,260	891	23.9
51	7,620	476	16.0
53	4,740	313	15.1
54	11,785	639	18.4
55	22,785	1,114	20.5
56	26,630	1,158	23.0
61	11,345	511	22.2
66	27,055	1,381	19.6
101	19,985	963	20.8
108	41,500	2,258	18.4
112.01	58,880	2,965	19.9
116	25,555	931	27.4
Orange County			
216	41,320	1,618	25.5
217	23,315	1,060	22.0
220	36,650	1,634	22.4
222	26,250	1,257	20.9
223	58,910	2,839	20.8
224	53,780	2,600	20.7
Cameron Parish			
9702	36,015	1,747	20.6
Detailed Study Area Total/Average	657,230	30,502	21.5
Hardin County, Texas	592,630	20,314	29.2
Jefferson County, Texas	1,943,425	97,437	19.9
Orange County, Texas	758,520	34,839	21.8
Average of Texas Counties	1,098,192	50,863	23.6
Cameron Parish, Louisiana	103,620	4,071	25.5
Calcasieu Parish, Louisiana	1,560,330	77,899	20.0
Average of Louisiana Parishes	831,975	40,985	22.7
State of Louisiana	45,993,645	1,831,057	25.1
State of Texas	226,011,890	9,157,875	24.7

Source: U.S. Census Bureau (2000d).

northward in the afternoons. Another major commuter route is from suburban areas north of Orange, along SH 87/62 towards Orange and industrial employment centers in Orange County, and returning northward in the afternoons. Another important employment corridor is along SH 73/87 from the Port Arthur area towards industrial employment centers in Orange County in the mornings and back towards Port Arthur in the afternoons (Helen, 2002).

Length of Residency and Housing. Table 3.14-7 provides length of residence data for the study area population and compares them with county, parish, and state data. The "length of residency" category shows the year that residents moved into their household unit (as reported in the 2000 census). The 2000 census data show that a majority of residents living within the detailed study area census tracts moved into their homes between 1995 and 1998 (at 23.3 percent of housing units) and between 1999 and March of 2000 (at 17.9 percent of housing units). This trend was also true for residents of Jefferson County, Orange County, Calcasieu Parish, the State of Texas, and the State of Louisiana, although to slightly varying degrees. Also, significant percentages of detailed study area residents reported moving into their homes between 1980 and 1989 (at 16.7 percent of housing units). This trend was also true for residents of Orange County and Cameron Parish, with percentages that were slightly greater than in the detailed study area. It is noteworthy that Cameron Parish had substantial numbers of residents who moved into their homes from 1969 and earlier (at 18.1 percent of housing units). Finally, there is some variation among detailed study area census tracts in terms of household residency. Specifically, the following detailed study area census tracts had greater than 50 percent of residents moving into their homes before 1990: Jefferson County tracts 7, 51, 53, 54, 55, and 61. In the Texas portion of the study area, a majority of residents moved into their housing units between 1995 and 1998 (at 25.4 percent of housing units) and between 1999 and March of 2000 (at 18.9 percent). In the Louisiana portion of the study area, also, a majority of residents moved into their housing units between 1995 and 1998 (at 27.4 percent) and between 1999 and March of 2000 (at 20.4 percent).

Table 3.14-8 provides a tally of owner-occupied versus renter-occupied housing units for the detailed study area census tracts compared with study area counties, parishes and states, as reported by the 2000 census. The greatest percentage of owner-occupied housing units is found in Cameron Parish (at 85.1 percent), and the lowest percentage of owner-occupied housing units is found in Jefferson County (at 66.0 percent). Conversely, the highest percentage of renter-occupied housing units is found in Jefferson County (at 34.0 percent), and the lowest percentage of renter-occupied housing units is found in Cameron Parish (at 14.9 percent). The detailed study area was 72.3 percent owner-occupied housing units, and 27.7 percent renter-occupied housing units, which is a relatively low level of owner-occupied housing units compared with study area counties and parishes, and also lower than both Texas and Louisiana. The highest percentage of owner-occupied housing units within the detailed study area census tracts, is found in Orange County tracts 222 (at 89.0 percent) and 216 (at 87.8 percent), and the lowest percentage of owner-occupied housing units is found in Jefferson County tracts 16 (at 1.6 percent) and 1.03 (at 42.0 percent). The Louisiana portion of the study area has a slightly higher percentage of owner-occupied housing units (at 72.2 percent) than the Texas portion of the study area (at 70.6 percent).

Table 3.14-7
Detailed Study Area Length of Household Residency, 2000

	Number Occupied Housing Units	Year Householder Moved Into Residence											
		1999 to March 2000	%	1995 to 1998	%	1990 to 1994	%	1980 to 1989	%	1970 to 1979	%	1969 or Earlier	%
Hardin County													
306	1,009	187	18.5%	279	27.7%	213	21.1%	260	25.8%	127	12.6%	80	7.9%
Jefferson County													
1.03	1,058	266	25.1%	210	19.8%	191	18.1%	50	4.7%	179	16.9%	162	15.3%
7	1,445	302	20.9%	221	15.3%	192	13.3%	160	11.1%	248	17.2%	322	22.3%
10	619	145	23.4%	139	22.5%	63	10.2%	110	17.8%	43	6.9%	119	19.2%
16	69	12	17.4%	9	13.0%	36	52.2%	0	0.0%	0	0.0%	12	17.4%
17	997	173	17.4%	212	21.3%	123	12.3%	138	13.8%	132	13.2%	219	22.0%
51	763	102	13.4%	120	15.7%	142	18.6%	74	9.7%	79	10.4%	246	32.2%
53	437	68	15.6%	33	7.6%	14	3.2%	100	22.9%	88	20.1%	134	30.7%
54	717	117	16.3%	91	12.7%	119	16.6%	137	19.1%	134	18.7%	119	16.6%
55	1,070	130	12.1%	257	24.0%	144	13.5%	266	24.9%	195	18.2%	78	7.3%
56	1,172	179	15.3%	310	26.5%	168	14.3%	290	24.7%	118	10.1%	107	9.1%
61	990	105	10.6%	110	11.1%	96	9.7%	166	16.8%	73	7.4%	350	35.4%
66	1,752	418	23.9%	440	25.1%	245	14.0%	189	10.8%	154	8.8%	306	17.5%
101	1,021	158	15.5%	310	30.4%	182	17.8%	143	14.0%	82	8.0%	146	14.3%
108	2,010	356	17.7%	393	19.6%	372	18.5%	292	14.5%	221	11.0%	376	18.7%
112.01	2,401	385	16.0%	611	25.4%	452	18.8%	437	18.2%	142	5.9%	374	15.6%
116	848	137	16.2%	181	21.3%	136	16.0%	155	18.3%	47	5.5%	192	22.6%
Orange County													
216	1,413	260	18.4%	370	26.2%	234	16.6%	216	15.3%	190	13.4%	143	10.1%
217	988	194	19.6%	319	32.3%	97	9.8%	137	13.9%	122	12.3%	119	12.0%
220	1,539	256	16.6%	469	30.5%	228	14.8%	231	15.0%	183	11.9%	172	11.2%
222	1,021	146	14.3%	281	27.5%	131	12.8%	246	24.1%	155	15.2%	62	6.1%
223	2,331	476	20.4%	458	19.6%	326	14.0%	468	20.1%	338	14.5%	265	11.4%
224	2,238	463	20.7%	617	27.6%	324	14.5%	394	17.6%	208	9.3%	232	10.4%
Cameron County													
9702	1,654	258	15.6%	462	27.9%	236	14.3%	292	17.7%	204	12.3%	202	12.2%
Detailed Study Area Total	29,562	5,293	17.9%	6,902	23.3%	4,464	15.1%	4,951	16.7%	3,462	11.7%	4,537	15.3%
Hardin County, Texas	17,805	2,927	16.4%	4,974	27.9%	3,426	19.2%	2,850	16.0%	2,196	12.3%	1,432	8.0%
Jefferson County, Texas	92,880	18,360	19.8%	23,162	24.9%	14,190	15.3%	13,995	15.1%	10,000	10.8%	13,173	14.2%
Orange County, Texas	31,642	5,639	17.8%	8,067	25.5%	4,793	15.1%	5,421	17.1%	4,161	13.2%	3,561	11.3%
Total Texas Study Area Counties	142,327	26,926	18.9%	36,203	25.4%	22,409	15.7%	22,266	15.6%	16,357	11.5%	18,166	12.8%
Cameron Parish, Louisiana	3,592	540	15.0%	837	23.3%	526	14.6%	634	17.7%	406	11.3%	649	18.1%
Calcasieu Parish, Louisiana	68,613	14,157	20.6%	18,950	27.6%	9,694	14.1%	9,538	13.9%	7,769	11.3%	8,505	12.4%
Total Louisiana Study Area Parishes	72,205	14,697	20.4%	19,787	27.4%	10,220	14.2%	10,172	14.1%	8,175	11.3%	9,154	12.7%
State of Texas	7,393,354	1,842,731	24.9%	2,233,669	30.2%	1,126,526	15.2%	1,030,476	13.9%	630,749	8.5%	529,203	7.2%
State of Louisiana	1,656,053	309,663	18.7%	446,127	26.9%	258,185	15.6%	253,627	15.3%	194,288	11.7%	194,163	11.7%

Source: U.S. Census Bureau (2000e).

Table 3.14-8
Detailed Study Area Household Tenure, 2000

Place/Detailed Study Area Census Tracts	Number of Occupied Household Units	Owner Occupied Units	Percent Owner Occupied Units	Renter Occupied Units	Percent Renter Occupied Units
Hardin County					
306	1,146	997	87.0	149	13.0
Jefferson County					
1.03	1,087	457	42.0	630	58.0
7	1,445	778	53.8	667	46.2
10	610	263	43.1	347	56.9
16	64	1	1.6	63	98.4
17	1,019	653	64.1	366	35.9
51	753	530	70.4	223	29.6
53	445	294	66.1	151	33.9
54	709	465	65.6	244	34.4
55	1,070	756	70.7	314	29.3
56	1,172	871	74.3	301	25.7
61	886	585	66.0	301	34.0
66	1,762	820	46.5	942	53.5
101	1,021	752	73.7	269	26.3
108	2,010	1,425	70.9	585	29.1
112.01	2,401	2,000	83.3	401	16.7
116	848	721	85.0	127	15.0
Orange County					
216	1,413	1,241	87.8	172	12.2
217	988	761	77.0	227	23.0
220	1,539	1,109	72.1	430	27.9
222	1,021	909	89.0	112	11.0
223	2,331	1,931	82.8	400	17.2
224	2,238	1,707	76.3	531	23.7
Cameron Parish					
9702	1,654	1,392	84.2	262	15.8
Detailed Study Area Total	29,632	21,418	72.3	8,214	27.7
Hardin County, Texas	17,805	14,717	82.7	3,088	17.3
Jefferson County, Texas	92,880	61,274	66.0	31,606	34.0
Orange County, Texas	31,642	24,424	77.2	7,218	22.8
Total Texas Study Area Counties	142,327	100,415	70.6	41,912	29.4
Cameron Parish, Louisiana	3,592	3,056	85.1	536	14.9
Calcasieu Parish, Louisiana	68,613	49,106	71.6	19,507	28.4
Total Louisiana Study Area Parishes	72,205	52,162	72.2	20,043	27.8
State of Louisiana	1,656,053	1,125,135	67.9	530,918	32.1
State of Texas	7,393,354	4,716,959	63.8	2,676,395	36.2

Source: U.S. Census Bureau (2000e).

Age Distribution. Table 3.14-9 shows the age characteristics of the detailed study area census tracts and provides a comparison with county-, parish-, and state-level data. Within the detailed study area census tracts, the median age in 2000 was 35.3, which is consistent with county and parish figures but higher than the State of Louisiana (at 34.0) and the State of Texas (at 32.3). In general, a majority of the detailed study area population is within the 25 to 34 (at 12.4 percent), the 35 to 44 (at 16.2 percent), and the 45 to 54 (at 14.1 percent) age cohorts. In the states of Texas and Louisiana, these same age cohorts represent a majority of the population, but to a lesser extent than in the detailed study area population. In Texas, the 25 to 34 cohort represents 15.2 percent, the 35 to 44 cohort represents 15.9 percent, and the 45 to 54 cohort represents 12.5 percent. In Louisiana, the 25 to 34 cohort represents 13.5 percent, the 35 to 44 cohort represents 15.5 percent, and the 45 to 54 cohort represents 13.1 percent. The Texas portion of the detailed study area has a slightly higher median age (at 35.9) than the Louisiana portion of the study area (at 34.8). In the Texas portion of the study area, a majority of the population is within the 35 to 44 age cohort (at 15.8 percent) and within the 45 to 54 age cohort (at 13.2 percent). In the Louisiana portion of the study area, a majority of the population is within the 35 to 44 age cohort (at 15.8 percent) and within the 45 to 54 age cohort (at 13.2 percent).

One reason that the study area population (including study area counties and parishes and the detailed study area census tracts) has a higher median age, and a larger "baby boomer" population than the states of Louisiana and Texas, is that opportunities for higher education are not as readily available within the study area, as compared with cities offering higher education in Louisiana and Texas. As a result, many young adults move away from the study area, for higher education opportunities elsewhere in Texas, Louisiana, or other states. Also, the spike in the "baby boomer"–aged population may be a result of families of "baby boomer" age returning to the study area (returning to where they grew up) after living elsewhere to pursue higher education and/or careers (Helen, 2002).

3.14.2.3 Demographics and Community Cohesion Factors Summary

Analysis of demographic and community cohesion factors within the study area and within the detailed study area suggests a moderate degree of community diversity. Study area counties and parishes exhibit low to moderate differences in levels of educational attainment. In terms of high school education, the detailed study area was consistent with study area counties and parishes. In terms of higher education, the detailed study area had achieved a relatively low level of educational attainment when compared with study area counties and parishes. There are some wide differences in levels of educational attainment among individual detailed study area census tracts. Study area median family income in 1999 by study area counties and parishes shows a fair amount of overall homogeneity. However, the detailed study area population had a substantially lower median family income than any of the study area counties and parishes. Also, median family incomes within the individual detailed study area census vary significantly, showing a high degree of community diversity. In terms of the median travel time to work, study area counties and parishes vary somewhat, varying from about 20 to 29 minutes. The detailed study area population has a relatively low average commute time when compared with the study area counties and parishes, and individual detailed study area census tracts show a relatively small degree of variation in commute times. In terms of length of household residency, the study area counties and parishes had a

Table 3.14-9
Detailed Study Area Age Characteristics, 2000

Place/Detailed Study Area Census Tracts	Years of Age: under 5 #	%	5 to 9 #	%	10 to 14 #	%	15 to 19 #	%	20 to 24 #	%	25 to 34 #	%	35 to 44 #	%	45 to 54 #	%	55 to 59 #	%	60 to 64 #	%	65 to 74 #	%	75 to 84 #	%	85 and over #	%	Total Persons	Median Age
Hardin County																												
306	218	7.0%	235	7.5%	260	8.3%	270	8.7%	179	5.7%	400	12.8%	554	17.8%	397	12.7%	158	5.1%	129	4.1%	182	5.8%	103	3.3%	31	1.0%	3,116	31.0
Jefferson County																												
1.03	440	14.3%	350	11.3%	265	8.6%	214	6.9%	309	10.0%	420	13.6%	333	10.8%	286	9.3%	113	3.7%	113	3.7%	151	4.9%	68	2.2%	22	0.7%	3,084	24.4
7	314	8.3%	354	9.4%	317	8.4%	355	9.4%	246	6.5%	373	9.9%	475	12.6%	483	12.8%	171	4.5%	170	4.5%	264	7.0%	205	5.4%	52	1.4%	3,779	33.1
10	120	6.9%	114	6.6%	143	8.2%	127	7.3%	123	7.1%	200	11.5%	232	13.3%	187	10.8%	83	4.8%	72	4.1%	139	8.0%	100	5.8%	99	5.7%	1,739	37.2
16	2	1.9%	0	0.0%	9	8.7%	21	20.2%	2	1.9%	3	2.9%	7	6.7%	7	6.7%	2	1.9%	1	1.0%	17	16.3%	16	15.4%	17	16.3%	104	58.0
17	161	5.8%	192	6.9%	211	7.6%	219	7.9%	143	5.2%	287	10.3%	402	14.5%	326	11.7%	133	4.8%	122	4.4%	230	8.3%	209	7.5%	141	5.1%	2,776	39.7
51	68	4.0%	117	6.9%	131	7.8%	129	7.6%	68	4.0%	170	10.1%	219	13.0%	219	13.0%	98	5.8%	76	4.5%	166	9.8%	169	10.0%	59	3.5%	1,689	42.3
53	66	5.7%	71	6.2%	100	8.7%	104	9.0%	66	5.7%	114	9.9%	159	13.8%	154	13.3%	69	6.0%	70	6.1%	107	9.3%	62	5.4%	12	1.0%	1,154	38.8
54	130	6.3%	149	7.3%	182	8.9%	222	10.8%	128	6.2%	229	11.2%	297	14.5%	273	13.3%	96	4.7%	93	4.5%	177	8.6%	57	2.8%	20	1.0%	2,053	34.5
55	244	7.3%	325	9.7%	316	9.4%	314	9.4%	234	7.0%	412	12.3%	465	13.9%	425	12.7%	133	4.0%	86	2.6%	197	5.9%	127	3.8%	74	2.2%	3,352	30.6
56	366	9.4%	417	10.7%	371	9.5%	374	9.6%	273	7.0%	565	14.5%	530	13.6%	426	10.9%	128	3.3%	89	2.3%	160	4.1%	143	3.7%	51	1.3%	3,893	27.8
61	98	4.6%	156	7.3%	167	7.8%	166	7.8%	100	4.7%	214	10.0%	326	15.2%	251	11.7%	84	3.9%	108	5.0%	260	12.2%	176	8.2%	33	1.5%	2,139	40.3
66	625	12.7%	533	10.9%	464	9.5%	424	8.6%	378	7.7%	583	11.9%	615	12.5%	469	9.6%	146	3.0%	125	2.5%	314	6.4%	180	3.7%	49	1.0%	4,905	25.4
101	344	10.5%	365	11.1%	292	8.9%	286	8.7%	217	6.6%	454	13.8%	491	14.9%	331	10.1%	110	3.3%	88	2.7%	118	3.6%	146	4.4%	45	1.4%	3,287	27.8
108	366	7.0%	403	7.7%	390	7.5%	388	7.4%	339	6.5%	705	13.5%	861	16.5%	658	12.6%	205	3.9%	199	3.8%	378	7.3%	260	5.0%	58	1.1%	5,210	35.2
112.01	393	5.5%	425	5.9%	496	6.9%	643	9.0%	543	7.6%	953	13.3%	1,326	18.5%	933	13.0%	342	4.8%	300	4.2%	502	7.0%	254	3.5%	65	0.9%	7,175	36.1
116	138	6.0%	146	6.3%	194	8.4%	218	9.4%	117	5.1%	275	11.9%	387	16.8%	315	13.7%	124	5.4%	114	4.9%	188	8.1%	84	3.6%	7	0.3%	2,307	37.3
Orange County																												
216	281	7.2%	274	7.0%	344	8.8%	324	8.2%	221	5.6%	541	13.8%	635	16.2%	529	13.5%	215	5.5%	195	5.0%	221	5.6%	123	3.1%	26	0.7%	3,929	34.7
217	189	7.2%	204	7.8%	190	7.2%	203	7.7%	161	6.1%	341	13.0%	395	15.1%	364	13.9%	99	3.8%	118	4.5%	211	8.0%	108	4.1%	40	1.5%	2,623	35.6
220	320	7.8%	313	7.7%	332	8.1%	308	7.5%	321	7.9%	566	13.9%	592	14.5%	506	12.4%	180	4.4%	165	4.0%	295	7.2%	150	3.7%	34	0.8%	4,082	32.8
222	176	5.8%	235	7.8%	317	10.5%	289	9.5%	168	5.6%	295	9.7%	585	19.3%	465	15.4%	116	3.8%	109	3.6%	187	6.2%	68	2.2%	17	0.6%	3,027	35.7
223	371	5.7%	457	7.1%	537	8.3%	557	8.6%	382	5.9%	713	11.0%	1,074	16.6%	961	14.8%	353	5.5%	280	4.3%	519	8.0%	231	3.6%	40	0.6%	6,475	37.1
224	419	7.0%	462	7.8%	455	7.6%	499	8.4%	363	6.1%	772	13.0%	934	15.7%	844	14.2%	297	5.0%	208	3.5%	424	7.1%	218	3.7%	55	0.9%	5,950	35.1
Cameron Parish																												
9702	322	7.1%	323	7.1%	370	8.1%	360	7.9%	320	7.0%	544	11.9%	755	16.6%	624	13.7%	248	5.4%	214	4.7%	303	6.7%	131	2.9%	39	0.9%	4,553	35.5
Detailed Study Area Total/Average	6,171	7.5%	6,620	8.0%	6,853	8.3%	7,014	8.5%	5,401	6.6%	10,129	12.3%	12,649	15.4%	10,433	12.7%	3,703	4.5%	3,244	3.9%	5,710	6.9%	3,388	4.1%	1,086	1.3%	82,401	35.3
Hardin County	3,337	6.9%	3,615	7.5%	3,865	8.0%	3,949	8.2%	2,698	5.6%	5,930	12.3%	7,656	15.9%	6,606	13.7%	2,566	5.3%	1,987	4.1%	3,356	7.0%	1,910	4.0%	598	1.2%	48,073	36.0
Jefferson County	16,925	6.7%	18,187	7.2%	18,476	7.3%	19,336	7.7%	17,666	7.0%	34,164	13.6%	39,779	15.8%	32,624	12.9%	11,053	4.4%	9,572	3.8%	17,933	7.1%	12,253	4.9%	4,083	1.6%	252,051	35.5
Orange County	5,712	6.7%	6,461	7.6%	6,683	7.9%	6,767	8.0%	4,983	5.9%	10,515	12.4%	13,351	15.7%	11,610	13.7%	4,350	5.1%	3,758	4.4%	6,243	7.3%	3,529	4.2%	1,004	1.2%	84,966	36.1
Total Texas Study Area Counties	25,974	6.7%	28,263	7.3%	29,024	7.5%	30,052	7.8%	25,347	6.6%	50,609	13.1%	60,786	15.8%	50,840	13.2%	17,969	4.7%	15,317	4.0%	27,532	7.1%	17,692	4.6%	5,685	1.5%	385,090	35.9
Cameron Parish	667	6.7%	757	7.6%	871	8.7%	821	8.2%	663	6.6%	1,218	12.2%	1,744	17.5%	1,257	12.6%	490	4.9%	445	4.5%	660	6.6%	293	2.9%	105	1.1%	9,991	35.0
Calcasieu Parish	13,253	7.2%	13,792	7.5%	14,036	7.6%	15,147	8.3%	12,925	7.0%	23,793	13.0%	28,912	15.7%	24,220	13.2%	8,492	4.6%	7,248	3.9%	12,399	6.8%	7,152	3.9%	2,208	1.2%	183,577	34.5
Total Louisiana Study Area Parishes	13,920	7.2%	14,549	7.5%	14,907	7.7%	15,968	8.2%	13,588	7.0%	25,011	12.9%	30,656	15.8%	25,477	13.2%	8,982	4.6%	7,693	4.0%	13,059	6.7%	7,445	3.8%	2,313	1.2%	193,568	34.8
State of Louisiana	317,392	7.1%	336,780	7.5%	347,912	7.8%	365,945	8.2%	325,571	7.3%	601,162	13.5%	691,966	15.5%	586,271	13.1%	208,761	4.7%	170,287	3.8%	282,925	6.3%	175,328	3.9%	58,676	1.3%	4,468,976	34.0
State of Texas	1,624,628	7.8%	1,654,184	1.8%	1,631,192	7.8%	1,636,232	7.8%	1,539,404	7.4%	3,162,083	15.2%	3,322,238	15.9%	2,611,137	12.5%	896,521	4.3%	701,669	3.4%	1,142,608	5.5%	691,984	3.3%	237,940	1.1%	20,851,820	32.3

Source: U.S. Census Bureau (2000f).

majority of residents moving into their housing units relatively recently (since 1995). The only exception was Cameron Parish, where a large proportion of residents had moved into their housing units prior to 1970, although this has changed due to the devastating effects of Hurricane Rita on the parish. The detailed study area also had a majority of the households moving into their housing units since 1995, but there is a high degree of variability within individual census tracts related to the year that households moved into their housing units. The study area counties and parishes have a low degree of variation related to the percentage of housing units that are owner-occupied, with all counties and parishes having between 70 and 83 percent owner-occupied housing units. The detailed study area census tracts had a proportion of owner-occupied housing units that was lower than that of the study area counties and parishes. There was a high degree of variability in individual detailed study area census tracts in terms of the percentage of owner-occupied housing units, varying from 1.6 to 89 percent. In terms of median age, there was very little variation among study area counties and parishes, with the median age varying from 34.5 to 36.1. The average detailed study area median age was consistent with the study area counties and parishes. However, there was a moderate to high degree of variability among individual detailed study area census tracts in terms of median age, varying from 24.4 to 58.0. In general, the population living within the study area and the detailed study area demonstrated a moderate level of community diversity judging from the community cohesion factors evaluated in this section.

3.14.2.4 Environmental Justice

In compliance with Executive Order (EO) 12898 – Federal Action to Address EJ in minority populations and low-income populations, an analysis has been performed to determine whether the proposed project would have a disproportionately adverse impact on minority or low-income population groups within the detailed study area. The EO requires that minority and low-income populations do not receive disproportionately high and adverse human health or environmental impacts and requires that representatives of minority or low-income populations, who could be affected by the project, be involved in the community participation and public involvement process.

3.14.2.4.1 EJ Index Methodology

Three levels of analysis are provided to help determine whether there is potential for disproportionately high and adverse effects accruing to the population living within the detailed study area. These analyses were patterned after the EPA Region 6 model called the EJ Index, which depicts a survey of ethnicity and income within the study area (EPA, 2003). The raw data used to recreate the analysis are based on 2000 U.S. Census Bureau census tract–level data for ethnicity and tract-level data for income data (U.S. Census Bureau, 2000a, 2000b).

The EPA EJ Index model is a modification of the Region's Human Health Risk Index Formula. The model uses GIS and census data to delineate the demographics within census tracts. The EJ Index model calculates the degree of vulnerability for the area based on population density and two socioeconomic criteria: a community's percentage minority population and percentage of economically stressed households. This information is then compared with the calculated State index and a ranking criterion is established. There are three ranking variables that comprise the EJ Index: population density, minority status, and economic status.

A score is assigned to each detailed study area tract that represents the population density. The criterion used to determine the population density score (from 0 to 4) is based on the number of persons per square mile. If a tract has no persons living within it, it is given a ranking score of 0, a population of 1 to 200 is ranked as 1, a population of greater than 200 but less than 1,000 is ranked as 2, a population of greater than 1,000 but less than 5,000 is ranked as 3, and a population of greater than 5,000 is ranked as 4.

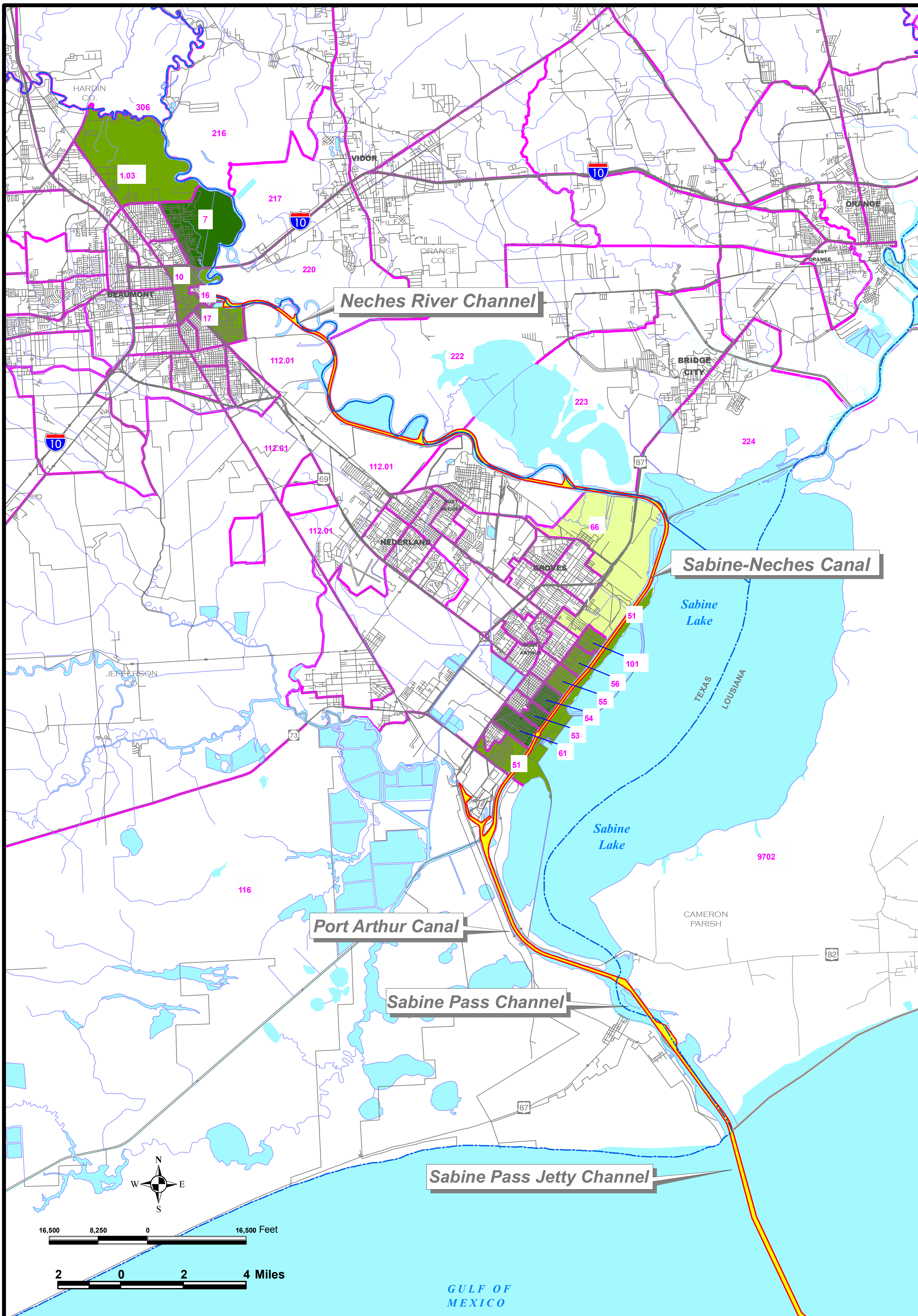
A score is also assigned to each detailed study area tract that represents the percentage of minority population and the percentage of economically stressed persons. To establish the rankings for both the minority population and the percentage of economically stressed persons, each tract is assigned a score that represents how that tract compares to the state's percentage (SP). Therefore, a score of 1 indicates that the tract's average is less than or equal to the SP, a score of 2 indicates that the tract is greater than the SP, but less than or equal to 1.33 times the SP, a score of 3 indicates that the tract is greater than 1.33 times the SP, but less than or equal to 1.66 times the SP, a score of 4 indicates that the tract is greater than 1.66 times the SP, but less than or equal to 1.99 times the SP, and a score of 5 indicates that the tract is equal to or greater than twice the SP. The EJ Index score is established by multiplying the population density score with the minority status score and the economically stressed score.

3.14.2.4.2 Minority Status Degree of Vulnerability

The Minority Status Degree of Vulnerability figure (Figure 3.14-2a) portrays the degree of vulnerability for minority status by detailed study area census tract. The percentages of minority populations that are living within census tracts that overlap into the detailed study area (entirely or partially) are compared with the respective SP of minority population. Tracts that are located within the State of Texas were compared with Texas's percentage of 47.5 percent, and tracts that are located within the State of Louisiana were compared with Louisiana's percentage of 37.4 percent. Minority status is defined to include all non-white as well as Hispanic-origin households. A ranking score (as described in the EJ Index Methodology) is assigned to each tract.

3.14.2.4.3 Economic Status Degree of Vulnerability

The Economic Status Degree of Vulnerability figure (Figure 3.14-2b) shows the percentage of economically stressed persons (or economically vulnerable) based on household income (the risk group is defined by the EPA – Region 6 as households with incomes less than $15,000 per year). The percentage of economically stressed persons who are living within the detailed study area census tracts that overlap into the detailed study area (entirely or partially) are compared with the respective SP of economically stressed households. Census tracts that are located within the State of Texas were compared with Texas's percentage of 15 percent, and tracts that are located within the State of Louisiana were compared with Louisiana's percentage of 19 percent. A ranking score (as described in the EJ Index Methodology) is assigned to each tract.



Potential Environmental Justice Index for the Detailed Study Area Census Tracts

Persons Per Sq. Mile	1377
Population Ranking	3
Percent Minority	48.8%
Minority Status	3
Percent Economically Stressed	20.6%
Economic Status	3
Environmental Justice Index	27

Percent Minority by Census Tract

- Less than the State Percentage (SP)
- > the SP but <=1.33 times the SP
- > 1.33 times the SP but <= 1.66 times the SP
- > 1.66 times the SP but <= 1.99 times the SP
- >= 2 times the SP

Census Tract Boundary

Project Area, Proposed Channel

Source: US Census Bureau, 2009g (Summary File 3 [SF3] Data)

Figure 3.14-2a

Detailed Study Area Minority Status 2000

Prepared for: USACE Galveston

Job No.: 100007609	Scale: 1" = 16500'
Prepared by: 18895/ 20192	Date: 09/10/2009

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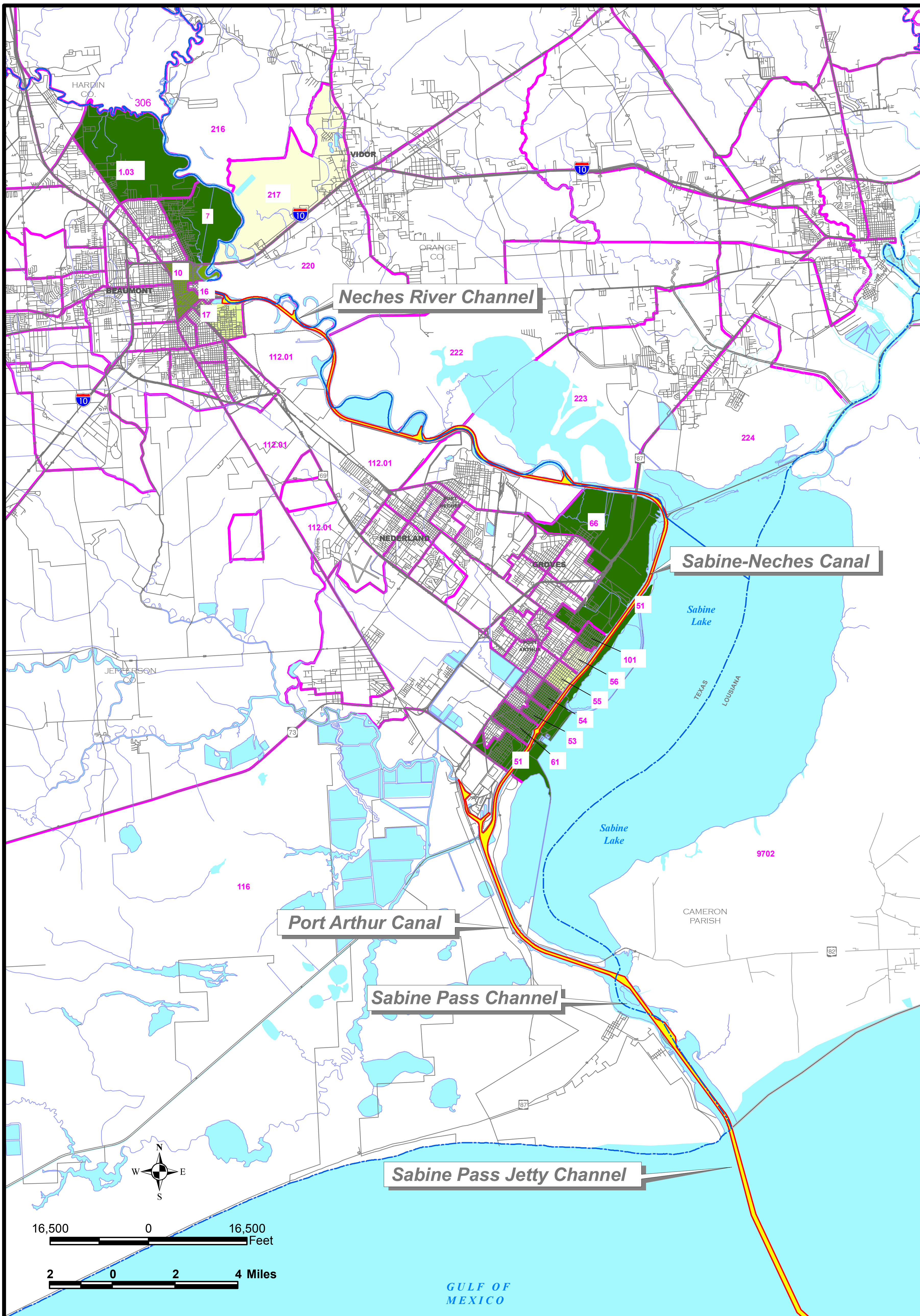

Potential Environmental Justice Index for the Detailed Study Area Census Tracts

Persons Per Sq. Mile Population Ranking	1377 3
Percent Minority Minority Status	48.8% 3
Percent Economically Stressed Economic Status	20.6% 3
Environmental Justice Index	27

Percent Economically Stressed by Census Tract

- Less than the State Percentage (SP)
- > the SP but <=1.33 times the SP
- > 1.33 times the SP but <= 1.66 times the SP
- > 1.66 times the SP but <= 1.99 times the SP
- >= 2 times the SP

Census Tract Boundary

Project Area, Proposed Channel

Source: US Census Bureau, 2009g (Summary File 3 [SF3] Data)

Figure 3.14-2b

Detailed Study Area Economic Status 2000

Prepared for: USACE Galveston

Job No.: 100007609	Scale: 1" = 16500'
Prepared by: 18895/20192	Date: 09/10/2009

N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/geo/figs/Census_2000_economic_status_vr5.mxd

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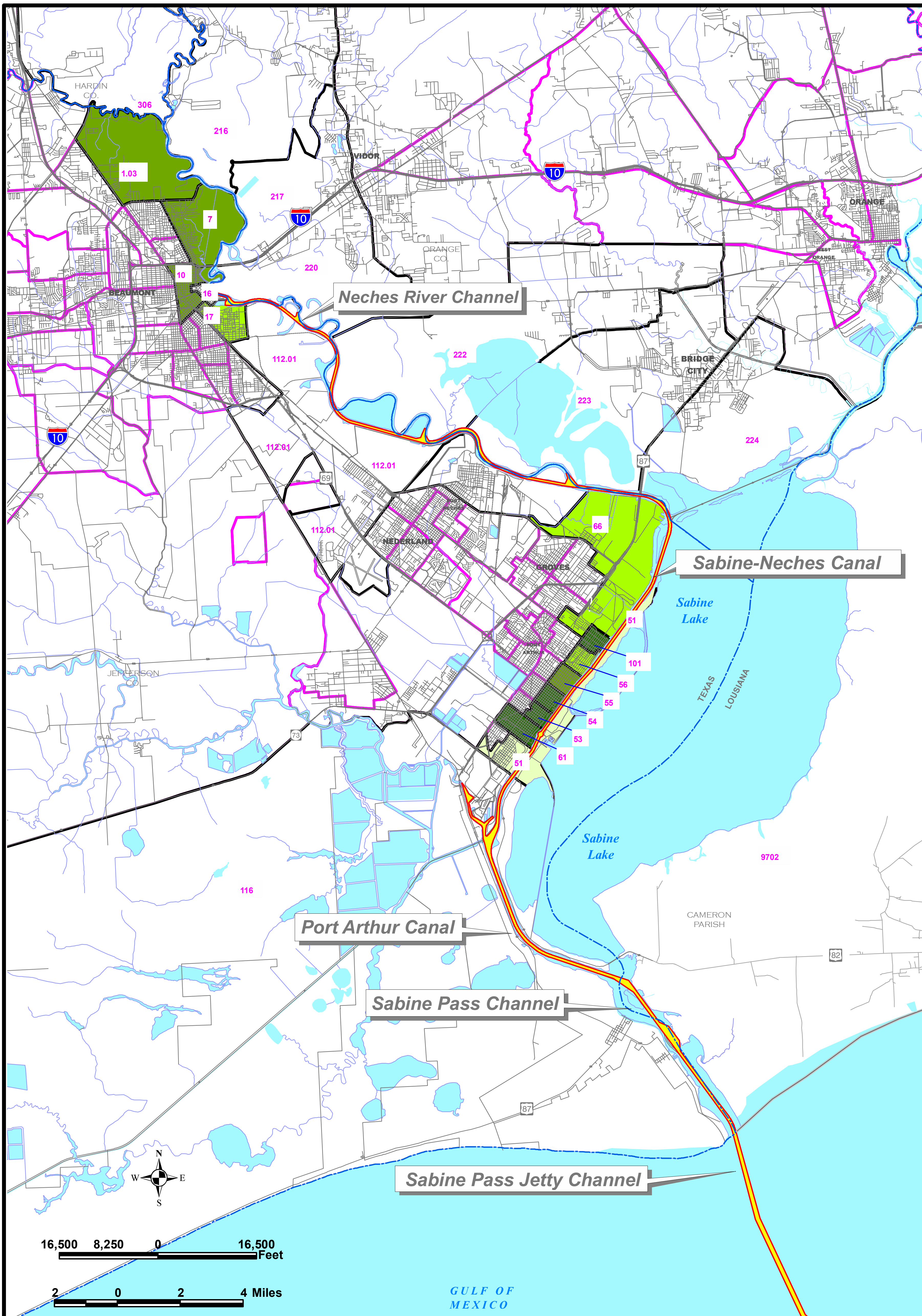

Potential Environmental Justice Index for the Detailed Study Area Census Tracts

Persons Per Sq. Mile	1377
Population Ranking	3
Percent Minority	48.8%
Minority Status	3
Percent Economically Stressed	20.6%
Economic Status	3
Environmental Justice Index	27

Criteria Ranked by Census Tract

- 1 to 12
- 13 to 25
- 26 to 37
- 38 to 50
- 51 to 100

Census Tract Boundary

Project Area, Proposed Channel

Source: US Census Bureau, 2009g (Summary File 3 [SF3] Data

Figure 3.14-2c
Detailed Study Area
Environmental Justice Index

Prepared for: USACE Galveston

Job No.: 100007609	Scale: 1" = 16500'
Prepared by: 18895/20192	Date: 09/10/2009

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3.14.2.4.4 Potential Environmental Justice Index

The Potential Environmental Justice Index figure (Figure 3.14-2c) shows a composite index incorporating population density, income, and ethnicity factors. Because the EJ Index is derived in part by the population of the project area, there is no county or state EJ Index number for comparison purposes.

3.14.2.4.5 Environmental Justice Index Analysis

The Minority Status Degree of Vulnerability figure (Figure 3.14-2a) shows that the detailed study area's population density (on average) is ranked as a 3, and the average percentage of ethnic minorities is 48.8 percent, which is substantially greater than all counties and parishes of the study area, greater than the State of Louisiana, and slightly greater than the State of Texas. The overall minority status for the detailed study area is ranked 3.

The Economic Status Degree of Vulnerability figure (Figure 3.14-2b) shows that the detailed study area census tracts have an average of 20.6 percent of the population that is economically stressed, which is slightly greater than in all study area counties and parishes, and the states of Texas and Louisiana. The overall economically stressed status is ranked 3.

The Potential Environmental Justice Index figure (Figure 3.14-2c) shows that the overall EJ Index for the detailed study area is 27. In addition to the EJ Index methodology, an analysis of the census tracts was also performed. The census tract data were used in this study to determine the potential for disproportionate effects to low-income and/or minority populations within the detailed study area and are presented in Table 3.14-10. The information is based on 2000 U.S. Census Bureau state, county, and census tract–level data for ethnicity and income (see Figure 3.14-1). All study area census tracts that overlap into the detailed study area (entirely or partially) were used in this analysis.

3.14.2.4.6 Census Tract Analysis

Within the detailed study area census tracts, the average percentage of African Americans is 26.7 percent, which is lower than the percentage of African Americans in Jefferson County (33.4 percent) and the State of Louisiana (32.2 percent), but is higher than the percentage of African Americans in Orange County (8.6 percent), Hardin County (6.9 percent), Cameron Parish (3.5 percent), Calcasieu Parish (23.5 percent), and the State of Texas (11.3 percent). Individual detailed study area census tracts with unusually high percentages of African Americans include the following: Jefferson County tracts 1.03, 7, 17, 51, 53, 54, 55, 61, and 66. The average percentage of Hispanics within the detailed study area is 9.6 percent, which is lower than Jefferson County (10.6 percent) and the State of Texas (32.0 percent), but is higher than the percentage of Hispanics in Orange County (3.5 percent), Hardin County (2.4 percent), Cameron Parish (2.1 percent), Calcasieu Parish (1.7 percent), and the State of Louisiana (2.4 percent). Individual detailed study area census tracts with unusually high percentages of Hispanics include the following: Jefferson County tracts 10, 56, and 101. The average percentage of "Other Race" population within the detailed study area is 4.1 percent, which is lower than the percentage of "other races" in Jefferson County (4.1 percent), the State of Louisiana (2.9 percent), and the State of Texas (4.3 percent), but is higher than

Table 3.14-10
Detailed Study Area Ethnic Distribution and Poverty Status, 2000

Place/Detailed Study Area Census Tracts	Population	Number White	Percent White	Number African American	Percent African American	Number Hispanic Origin	Percent Hispanic	Number Other	Percent Other	Number Below Poverty	Percent Below Poverty
Hardin County											
306	3,116	2,965	95.2%	5	0.2%	61	2.0%	85	2.7%	216	6.9%
Jefferson County											
1.03	3,065	360	11.7%	2,605	85.0%	65	2.1%	35	1.1%	1,257	41.0%
7	3,779	104	2.8%	3,451	91.3%	172	4.6%	52	1.4%	1,321	35.0%
10	1,783	366	20.5%	711	39.9%	665	37.3%	41	2.3%	443	24.8%
16	105	76	72.4%	22	21.0%	0	0.0%	7	6.7%	0	0.0%
17	2,735	319	11.7%	2,385	87.2%	31	1.1%	0	0.0%	675	24.7%
51	1,842	119	6.5%	1,723	93.5%	0	0.0%	0	0.0%	711	38.6%
53	1,074	47	4.4%	934	87.0%	62	5.8%	31	2.9%	481	44.8%
54	2,133	63	3.0%	1,455	68.2%	386	18.1%	229	10.7%	691	32.4%
55	3,352	478	14.3%	1,710	51.0%	534	15.9%	630	18.8%	768	22.9%
56	3,893	585	15.0%	1,133	29.1%	1,613	41.4%	562	14.4%	608	15.6%
61	2,100	12	0.6%	1,960	93.3%	116	5.5%	12	0.6%	783	37.3%
66	4,752	1,444	30.4%	2,102	44.2%	753	15.8%	453	9.5%	1,843	38.8%
101	3,287	668	20.3%	896	27.3%	1,490	45.3%	233	7.1%	994	30.2%
108	5,210	4,760	91.4%	13	0.2%	377	7.2%	60	1.2%	351	6.7%
112.01	7,193	6,151	85.5%	603	8.4%	299	4.2%	140	1.9%	411	5.7%
116	2,307	2,040	88.4%	59	2.6%	158	6.8%	50	2.2%	195	8.5%
Orange County											
216	3,929	3,767	95.9%	0	0.0%	78	2.0%	84	2.1%	471	12.0%
217	2,623	2,473	94.3%	0	0.0%	113	4.3%	37	1.4%	493	18.8%
220	4,082	3,798	93.0%	12	0.3%	178	4.4%	94	2.3%	555	13.6%
222	3,027	2,853	94.3%	0	0.0%	84	2.8%	90	3.0%	159	5.3%
223	6,475	6,031	93.1%	6	0.1%	275	4.2%	163	2.5%	569	8.8%
224	5,950	5,508	92.6%	7	0.1%	245	4.1%	190	3.2%	639	10.7%
Cameron Parish											
9702	4,553	4,079	89.6%	229	5.0%	136	3.0%	109	2.4%	600	13.2%
Detailed Study Area Total	82,365	49,066	59.6%	22,021	26.7%	7,891	9.6%	3,387	4.1%	15,234	18.5%
Hardin County	48,073	42,714	88.9%	3,322	6.9%	1,176	2.4%	861	1.8%	5,314	11.1%
Jefferson County	252,051	130,655	51.8%	84,290	33.4%	26,664	10.6%	10,442	4.1%	41,142	16.3%
Orange County	84,966	72,921	85.8%	7,275	8.6%	2,978	3.5%	1,792	2.1%	11,518	13.6%
Total Texas Study Area Counties	385,090	246,290	64.0%	94,887	24.6%	30,818	8.0%	13,095	3.4%	57,974	15.1%
Cameron Parish, Louisiana	9,991	9,266	92.7%	354	3.5%	207	2.1%	164	1.6%	1,220	12.2%
Calcasieu Parish, Louisiana	183,577	133,607	72.8%	43,197	23.5%	3,166	1.7%	3,607	2.0%	27,582	15.0%
Total Louisiana Study Area Parishes	193,568	142,873	73.8%	43,551	22.5%	3,373	1.7%	3,771	1.9%	28,802	14.9%
State of Louisiana	4,468,974	2,794,348	62.5%	1,437,100	32.2%	107,854	2.4%	129,672	2.9%	851,113	19.0%
State of Texas	20,851,820	10,927,538	52.4%	2,349,641	11.3%	6,670,122	32.0%	904,519	4.3%	3,117,609	15.0%

Source: U.S. Census Bureau (2000a, 2000g).

the percentage of "Other Race" population in Orange County (2.1 percent), Hardin County (1.8 percent), Cameron Parish (1.6 percent), and Calcasieu Parish (2.0 percent). Individual detailed study area census tracts with unusually high percentages of "Other Race" persons include the following: Jefferson County tracts 54, 55, and 56.

The average percentage of persons living below the poverty level within the detailed study area is 18.5 percent, which is lower than the percentage of people living below the poverty level in the State of Louisiana (19.0 percent), but is higher than the percentage of people living below the poverty level in Jefferson County (16.3 percentage), Orange County (13.6 percent), Hardin County (11.1 percent), Cameron Parish (12.2 percent), Calcasieu Parish (15.0 percent), and the State of Texas (15.0 percent). Individual detailed study area census tracts with unusually high percentages of poverty status persons include the following: Jefferson County tracts 1.03, 7, 51, 53, 54, 61, 66, and 101.

3.14.2.4.7 Results

The results of the census tract analysis suggests that within the detailed study area census tracts, the potential for disproportionately high effects to ethnic minority populations is high, and the potential for disproportionately high effects to poverty status persons is moderate. The detailed study area exhibits a disproportionately high percentage of African Americans relative to other portions of the study area and the State of Texas. In addition, there are several detailed study area census tracts with exceptionally high percentages of African Americans. Also, the detailed study area has a moderately high percentage of Hispanics when compared with most counties and parishes within the study area and also the State of Louisiana. There are three detailed study area census tracts with unusually high percentages of Hispanics. Also, the detailed study area has an overall "Other Race" population that is slightly higher than four of the five study area counties and parishes. There are three detailed study area census tracts with unusually high percentages of "Other Race" population. The population living within the detailed study area census tracts has a moderately high percentage of poverty status when compared with most counties and parishes within the study area and the State of Texas. There are numerous census tracts within the detailed study area that have unusually high percentage of poverty status persons.

3.14.2.5 Port-Related Population

In subsection 3.14.3.3, the number of direct port-related employees for the Port of Beaumont, the Port of Port Arthur, and the Port of Orange is estimated at 41, 16, and 8, respectively, or a total of 65 direct employees for the three ports (Floyd, 2009; Myers, 2009). Applying a multiplier of 2.65 for the average household size within the study area, an estimate of the direct port-related population in the area is 172 persons. This represents only a very small fraction of the total population within the five-county study area.

Also, in subsection 3.14.3.3, it is estimated that total port-related employment in the port, manufacturing, and industrial industries is currently around 21,000. To estimate the population that is related to these industries, a multiplier of 2.65 was again applied to yield a port-related population of approximately

55,650 people. Since the study area consisted of 578,658 persons in 2000, this port/manufacturing/industrial population represents approximately 9.6 percent of the current study area population. This is an estimate of the population that has at least one family member that works in any of these industries that are either directly or indirectly linked to waterborne commerce. However, this estimate likely undercounts the population within the study area that is employed by companies that are suppliers to port, manufacturing, and industrial employers. Within the study area, outside vendors provide a wide diversity of expendables and services to these industries (Davis, 1996). Given that these estimates likely undercount the degree to which the local population depends on port, manufacturing, and industrial employment for its livelihood, it seems apparent that the a substantial portion of the population does depend on the these industries, probably at least 25 percent of the population. However, this dependency on port-related industry employment is less than it was before the 1980s "oil bust," as the study area economy has made adjustments since the 1980s (Helen, 2002). Now the study area population relies to a greater extent on industries such as services, Federal, State, and local government, retail and wholesale trade, medical services, education, and Federal and State jails for its livelihood.

3.14.3 Economics

3.14.3.1 Historical Perspective

The SNWW forms a Y-shaped set of interlocking river channels and canals extending from the Gulf to Port Arthur, Beaumont, and Orange, Texas. Extensive construction to improve the waterways began with river and harbor acts of 1875, 1882, and 1896, when the mouth of the channel was deepened and jetties were built to prevent silting. Some improvements in the Sabine and Neches rivers were authorized in 1878, and the Port Arthur Canal and Dock Company began building a more suitable channel to Port Arthur in 1895. The Port Arthur Canal opened in 1899. The discovery of the Spindletop oil field in 1901 increased demand for deepwater navigation along the lower Sabine and Neches rivers. In response, Congress provided authorization and money in 1905 to complete the GIWW from New Orleans to Galveston Bay. This channel was dredged to a depth of 9 feet and a width of 100 feet and provided a direct connection with the Port Arthur Canal. By 1916 Congress approved the extension of the Port Arthur Canal, and a 25-foot-deep channel was completed to Beaumont in 1916 (known as the Neches Channel). Additional dredging and improvements extended the waterway to Orange (known as the Sabine Channel). By 1972, the SNWW was 40 feet deep and 400 feet wide (University of Texas, 2001).

A series of jetties, canals, rivers, and turning basins now compose the waterway. At the mouth of the channel is Sabine Pass, with jetties extending 3 miles into the Gulf. Twenty-four miles north, up the SNWW, is Port Arthur. The SNWW then splits. To the west, the Port of Beaumont is 19 miles up the Neches River from Port Arthur. To the east, the Port of Orange is 15 miles above the confluence of the Sabine and Neches rivers, via the Sabine Channel. The SNWW, the Neches Channel, the Sabine Channel, and the GIWW have all been tremendously important to development within the study area. The system supported more than 45,000,000 tons of cargo annually by the late 1930s, and over 40,000 vessels used the waterway by 1943. In 1979 well over 75,000,000 tons passed through the Sabine Pass jetties, making the Sabine-Neches shipping district the second largest in the State of Texas, behind that of Galveston-

Houston-Texas City (University of Texas, 2001). In 2007, the SNWW ranked 4th in the Nation in total tonnage, importing 141 million short tons. Individually, the Port of Beaumont ranked 5th nationally for domestic and total tonnage, and the Port of Port Arthur ranked 28th in the Nation (IWR-WCUS, 2007).

3.14.3.2 Employment

Table 3.14-11 provides employment by major industry sector and total employment for the study area for three Texas counties, two Louisiana parishes, the State of Texas, and the State of Louisiana. In Texas, a study of the fourth-quarter data for 2006 and 2008 show that total employment in Hardin County decreased from 12,616 to 12,527 (–0.7 percent), Jefferson County increased from 123,417 to 127,523 (3.3 percent), and Orange County increased from 22,493 to 23,275 (3.5 percent). Total employment in the State of Texas increased from 10,104,642 to 10,512,878 (4.0 percent) during this same period (Texas Workforce Commission [TWC], 2009).

In Louisiana, a study of the fourth-quarter employment data for 2006 and 2008 show that total employment in Calcasieu Parish increased from 85,506 to 87,877 (2.8 percent), and Cameron Parish increased from 2,501 to 3,046 (21.8 percent). Total employment in the State of Louisiana increased from 1,843,179 to 1,903,858 (3.3 percent) during this same period (Louisiana Department of Labor [LDOL], 2005, 2009).

In Texas, fourth-quarter TWC employment data for 2008 show that the leading economic sectors in Hardin County were government (20.1 percent), retail trade (15.5 percent), and construction (11.5 percent). For Jefferson County, leading sectors are construction (14.4 percent), government (14.1 percent), and manufacturing (12.2 percent). For Orange County, the leading sectors were manufacturing (23.7 percent), government (19.1 percent), and retail trade (13.3 percent). State of Texas leader sectors were government (16.9 percent), retail (11.5 percent), and manufacturing (8.7 percent) (TWC, 2009).

In Louisiana, data for 2008 show that the leading economic sectors in Calcasieu Parish were construction (12.9 percent) and retail trade (12.4 percent); leading sectors in Cameron Parish are transportation and warehousing (14.8 percent) and construction (13.2 percent); for the State of Louisiana, retail trade (12.0 percent) and manufacturing (8.0 percent) (LDOL, 2009).

Table 3.14-12 provides unemployment data for the study area including three Texas counties, two Louisiana parishes, the State of Texas, and the State of Louisiana. In Texas, a study of TWC unemployment data in 1998, 2001, 2003, 2006, and 2008 indicates that the highest unemployment rates were as follows: Hardin County (7.8 percent in 2003), Jefferson County (8.6 percent in 2003), Orange County (9.8 percent in 2001), and the State of Texas (6.7 percent in 2003). The lowest unemployment rates for these areas are as follows: Hardin County (5.3 percent in 2006), Jefferson County (6.1 percent in 2006), Orange County (5.9 percent in 2006), and the State of Texas (4.8 percent in 1998).

Table 3.14-11
Study Area Major Employment Sectors

Employment Sector	4th Quarter Employment 2006	4th Quarter Employment 2008	Percent Total Employment 2006	Percent Total Employment 2008	Percent Change 2006–2008
Hardin County					
Agriculture, Forestry, Fishing, and Hunting	81	100	0.6	0.8	24.7
Mining	476	396	3.8	3.2	–16.8
Utilities	34	33	0.3	0.3	–2.9
Construction	1,867	1,443	14.8	11.5	–22.7
Manufacturing	1,016	795	8.1	6.3	–21.8
Wholesale Trade	315	402	2.5	3.2	27.6
Retail Trade	1,920	1,947	15.2	15.5	1.4
Transportation and Warehousing	147	168	1.2	1.3	14.3
Information	62	76	0.5	0.6	22.6
Finance and Insurance	206	189	1.6	1.5	–8.3
Real Estate and Rental Leasing	110	102	0.9	0.8	–7.3
Professional and Technical Services	179	210	1.4	1.7	17.3
Federal/State/Local Government	2,548	2,518	20.2	20.1	–1.2
Total Employment*	12,616	12,527	100.0	100.0	–0.7
Jefferson County					
Agriculture, Forestry, Fishing, and Hunting	158	143	0.1	0.1	–9.5
Mining	625	638	0.5	0.5	2.1
Utilities	1,213	1,259	1.0	1.0	3.8
Construction	12,178	18,385	9.9	14.4	51.0
Manufacturing	15,550	15,508	12.6	12.2	–0.3
Wholesale Trade	3,872	4,316	3.1	3.4	11.5
Retail Trade	15,766	15,474	12.8	12.1	1.9
Transportation and Warehousing	5,945	4,598	4.8	3.6	–22.7
Information	2,421	1,792	2.0	1.4	–26.0
Finance and Insurance	2,688	2,601	2.2	2.0	–3.2
Real Estate and Rental Leasing	1,905	1,719	1.5	1.3	–9.8
Professional and Technical Services	6,505	6,453	5.3	5.1	–0.8
Federal/State/Local Government	19,014	17,959	15.4	14.1	–5.5
Total Employment*	123,417	127,523	100.0	100.0	3.3
Orange County					
Agriculture, Forestry, Fishing, and Hunting	15	30	0.1	0.1	1.0
Mining	259	394	1.2	1.7	52.1
Utilities	318	332	1.4	1.4	4.4
Construction	1,451	1,954	6.5	8.4	34.7

Table 3.14-11, cont'd

Employment Sector	4th Quarter Employment		Percent Total Employment		Percent Change
	2006	2008	2006	2008	2006–2008
Manufacturing	5,082	5,512	22.6	23.7	8.5
Wholesale Trade	485	556	2.2	2.4	14.6
Retail Trade	3,174	3,093	14.1	13.3	–2.6
Transportation and Warehousing	745	747	3.3	3.2	0.3
Information	147	147	0.7	0.6	0.0
Finance and Insurance	780	853	3.5	3.7	9.4
Real Estate and Rental Leasing	180	208	0.8	0.9	15.6
Professional and Technical Services	657	403	2.9	1.7	–38.7
Federal/State/Local Government	4,547	4,448	20.2	19.1	–2.2
Total Employment*	22,493	23,275	100.0	100.0	3.5
State of Texas					
Agriculture, Forestry, Fishing, and Hunting	63,518	61,649	0.6	0.6	–2.9
Mining	194,188	236,690	1.9	2.3	21.9
Utilities	74,240	79,307	0.7	0.8	6.8
Construction	652,822	703,026	6.5	6.7	7.7
Manufacturing	943,090	918,704	9.3	8.7	–2.6
Wholesale Trade	507,253	527,792	5.0	5.0	4.0
Retail Trade	1,174,230	1,204,234	11.6	11.5	2.6
Transportation and Warehousing	441,559	452,243	4.4	4.3	2.4
Information	231,216	220,795	2.3	2.1	–4.5
Finance and Insurance	449,394	454,303	4.4	4.3	1.1
Real Estate and Rental Leasing	182,938	186,166	1.8	1.8	1.8
Professional and Technical Services	543,372	593,833	5.4	5.6	9.3
Federal/State/Local Government	1,717,411	1,780,480	17.0	16.9	3.7
Total Employment*	10,104,642	10,512,878	100.0	100.0	4.0
Calcasieu Parish					
Agriculture, Forestry, Fishing, and Hunting	183	247	0.2	0.3	35.0
Mining	1,016	1,191	1.2	1.4	17.2
Utilities	572	587	1	1	3
Construction	10,005	11,337	11.7	12.9	13.3
Manufacturing	8,683	8,849	10.2	10.1	1.9
Wholesale Trade	2,586	2,553	3.0	2.9	–1.3
Retail Trade	10,945	10,861	12.8	12.4	–0.8
Transportation and Warehousing	3,411	3,492	4.0	4.0	2.4
Information	1,169	1,243	1	1	6
Finance and Insurance	1,881	1,877	2	2	–0.2

Table 3.14-11, cont'd

Employment Sector	4th Quarter Employment		Percent Total Employment		Percent Change
	2006	2008	2006	2008	2006–2008
Real Estate and Rental Leasing	1,160	1,153	1.4	1.3	–0.6
Professional and Technical Services	3,605	3,599	4.2	4.1	–0.2
Federal/State/Local Government	NA	NA	NA	NA	NA
Total Employment*	85,506	87,877	100.0	100.0	2.8
Cameron Parish					
Agriculture, Forestry, Fishing, and Hunting	11	15	0.4	0.5	36.4
Mining	176	211	7.0	6.9	19.9
Utilities	NA	NA	NA	NA	NA
Construction	302	402	12.1	13.2	33.1
Manufacturing	235	302	9.7	9.9	28.5
Wholesale Trade	246	295	9.8	9.7	19.9
Retail Trade	115	89	4.6	2.9	–22.6
Transportation and Warehousing	480	450	19.2	14.8	–6.3
Information	NA	NA	NA	NA	NA
Finance and Insurance	NA	NA	NA	NA	NA
Real Estate and Rental Leasing	68	103	2.7	3.4	51.5
Professional and Technical Services	55	47	2.2	1.5	14.5
Federal/State/Local Government	NA	NA	NA	NA	NA
Total Employment*	2,501	3,046	100.0	100.0	21.8
State of Louisiana					
Agriculture, Forestry, Fishing, and Hunting	11,349	10,137	0.6	0.5	–10.7
Mining	47,606	53,154	2.6	2.8	11.7
Utilities	14,203	14,529	0.8	0.8	2.3
Construction	140,896	147,318	7.6	7.7	4.6
Manufacturing	155,394	151,603	8.4	8.0	–2.4
Wholesale Trade	73,709	75,233	4.0	4.0	2.1
Retail Trade	227,399	228,731	12.3	12.0	0.6
Transportation and Warehousing	79,770	81,311	4.3	4.3	1.9
Information	29,066	30,074	1.6	1.8	3.5
Finance and Insurance	58,886	58,608	3.2	3.1	–0.5
Real Estate and Rental Leasing	34,968	33,804	1.9	1.8	–3.3
Professional and Technical Services	80,358	86,570	4.4	4.5	7.7
Federal/State/Local Government	NA	NA	NA	NA	NA
Total Employment*	1,843,779	1,903,858	100.0	100.0	3.3

Source: TWC (2009); Louisiana Workforce Commission (2007, 2009).

*Total employment includes all industry sectors, including sectors not listed.

Table 3.14-12
Study Area Unemployment, 1998 to 2008

	% Annual Average Unemployment Rate				
	1998	2001	2003	2006	2008
Hardin County	6.1	6.8	7.8	5.3	5.5
Jefferson County	6.8	7.9	8.6	6.1	6.8
Orange County	8.6	9.8	9.4	5.9	6.6
Calcasieu Parish	5.5	6.1	6.6	3.3	4.8
Cameron Parish	4.4	5.9	6.4	2.9	4.7
State of Louisiana	5.7	6.0	6.6	4.3	4.6
State of Texas	4.8	5.1	6.7	4.9	4.9

Source: TWC (2009); Louisiana Workforce Commission (2007, 2009).

In Louisiana, LDOL data in 1998, 2001, 2003, 2006, and 2008 indicate that the highest unemployment rates were as follows: Calcasieu Parish (6.6 percent in 2003), Cameron Parish (6.4 percent in 2003), and the State of Louisiana (6.6 percent in 2003). The lowest unemployment rates were as follows: Cameron Parish (2.9 percent in 2006), Calcasieu Parish (3.3 percent in 2006), and the State of Louisiana (4.3 percent in 2006).

Table 3.14-13 provides a list of the top 20 major employers within the study area. The top employers are concentrated in the public education, health care, petrochemical, manufacturing, gambling, shipbuilding, Federal prisons, and other port-related industries. Together these top 20 (overall) employers provide over 41,000 jobs within the study area economy. Based on a labor force around 300,000 for the five-county/parish study area, this represents approximately 13.7 percent of employment within the five-county/parish study area. Among the top 20 employers, 8 of them are port-related employers (includes manufacturing employment), and these employers encompass 15,735 workers.

3.14.3.3 Port-Related Employment and Operations

Direct employment with the three study area ports, the Port of Beaumont, the Port of Port Arthur, and the Port of Orange, make up a very small fraction of the overall employment that is indirectly tied to port activities. Discussions with area port staff indicated that permanent full-time staff at the ports is as follows: Port of Beaumont (41 employees), the Port of Port Arthur (16 employees), and the Port of Orange (8 employees). Each of these ports also contracts with varying numbers of longshoreman to handle loading and unloading of cargo from ships when they are at port. Information on the average number of longshoremen was not readily available except in the case of the Port of Port Arthur where it was estimated that in an average month there are approximately 6,350 labor hours of employment, which is equivalent to approximately 40 full-time employees for that month, assuming a 40-hour-per-week schedule. Based on the yearly tonnage of cargo, it may be assumed that both the Port of Beaumont and the Port of Orange would have more longshoremen than the Port of Port Arthur (Bouillon, 2002; Davis, 2002; Floyd, 2009; Myers, 2009; Richard, 2002).

Table 3.14-13
Top 20 Employers, Study Area, 2008

Employers	Number of Employees
Calcasieu Parish School System	4,850
Beaumont Independent School District (ISD)	2,896
Exxon-Mobile Corporation	2,500
Christus St. Elizabeth Hospital	2,300
Turner Industries, LTD.	2,250
E.I. Dupont De Nemours	2,000
Dupont Sabine River Works	2,000
Memorial Hermann Baptist Beaumont Hospital	1,614
Bayer Corporation	1,600
Harrah's Lake Charles	1,600
Northrop Grumman Corporation	1,500
West Teleservices Corporation	1,464
PPG Industries	1,296
Citgo Petroleum Corporation	1,275
Lamar University	1,252
City of Beaumont	1,217
Isle of Capri Casino	1,171
Christus St. Patrick Hospital	1,085
Lake Charles Memorial Hospital	1,039

Source: Beaumont Independent School District (2008); Calcasieu Parish School Board (2008); Nederland Economic Development Corporation (2008); Southwest Louisiana - The Chamber (2008).

Conservative estimates of all port, manufacturing, and industrial-related employment, based on information from the U.S. Bureau of Labor Statistics indicates approximately 21,000 jobs in the study area in 2009 (TWC, 2009). It is likely, however, that an even greater number of port-related jobs exist within the area economy, as numerous small supplier companies provide goods and services to larger port, manufacturing, and industrial-related employers (Davis, 1996).

There are a few factors that have had effects on employment within port, manufacturing and industrial-related industries within the study area. One major factor that has led to relatively high unemployment levels within the study area has been a downturn in oil-related industries since the 1980s "oil bust." During the 1980s, the study area experienced relatively high unemployment rates, as oil refineries and other manufacturing plants laid off as many as 17,000 workers. Since, the 1980s the manufacturing and other port-related industries have been slow to add large increases in the workforce, so unemployment rates did not fully recover even during the national economic boom of the 1990s. The particular "industrial mix" of the study area, which is heavily concentrated in manufacturing, port-related, construction, transportation, and public utilities, is also susceptible to employment volatility due to heavy reliance on contract labor. As new contracts are awarded, employees are contracted to accomplish the work, and when the project is completed, these companies would lay off their workforce until the next contract is awarded unless current contracts can allow them to maintain staffing levels. In terms of competition for workers, the port-related, manufacturing, and industrial-related employers of the study area do not have to compete much with other industries in order to retain their workers. This is because overall these employers pay substantially higher wages than other industries that are important to the area, such as the services, retail and wholesale trade, and government services. Another factor affecting employment among manufacturing and port-related employers is an increased reliance on mechanized means of production. In many cases, large investments have been made to increase the size, capacity, and output of manufacturing plants and other port-related industries, but these expansions have led to relatively small increases in the number of employees (Crawley and Sanchez, 1999; Helen, 2002).

Table 3.14-14 provides a list of the top 10 industrial, manufacturing, and port-related employers in the study area. Collectively, these top 10 employers provide over 17,000 jobs to the area. Based on a labor force around 300,000 for the five-county/parish study area, this represents approximately 5.7 percent of employment within the five-county/parish study area.

Table 3.14-14
Top 20 Industrial, Manufacturing and Port-Related Employers – Study Area

Employers	Number of Employees
Exxon-Mobile Corporation	2,500
Turner Industries, LTD.	2,250
Dupont Sabine River Works	2,000
E.I. Dupont De Nemours	2,000
Master-Halo, Inc.	2,000
Bayer Corporation	1,600
Northrop Grumman Corporation	1,500
Motiva Corporation	1,300
PPG Industries	1,296
Citgo Petroleum Corporation	1,275

Source: Beaumont Chamber of Commerce (2005); Greater Orange Chamber of Commerce (2002); Nederland Economic Development Corporation (2008); Southwest Louisiana - The Chamber (2008).

Table 3.14-15 provides a list of the top 10 export commodities and import commodities at the Port of Beaumont, the Port of Orange, the Port of Port Arthur, and the Port of Sabine Pass. In terms of waterborne export commodities, 4 of the 10 top commodities being shipped are petroleum-based products, most of which are manufactured at plants located within the study area. The greatest export is petroleum coke at 3,777 short tons in 2003. In terms of waterborne import commodities, by far the single greatest waterborne commodity being received at these four study area ports (in terms of tonnage) is crude petroleum, at 69,260 short tons in 2003, or 91 percent of all inbound freight traffic tonnage. Examination of the top 10 import and export commodities provides a better understanding of the nature of the port-related economy within the study area. Because the single most important commodity (in terms of tonnage and value) being moved through the four ports is imported foreign crude petroleum, the price of oil on the foreign market has very large implications in terms of economic success for study area manufacturing plants, and most other port-related businesses. If the price for a barrel of oil is either too low or too high, the entire manufacturing, and port-related sector of the study area economy as well as overall-employment levels, and economic activity within the study area can be adversely affected. Other important nonpetroleum based commodities (both imports and exports) include wheat, sand and gravel, waste and scrap materials, and iron and steel products.

Table 3.14-15
Top 10 Waterborne Export and Import Commodities – Ports of Beaumont, Port Arthur, Orange, and Sabine Pass, 2003

	Short Tons
Top 10 Export Commodities*	
Petroleum Coke	3,777
Gasoline	1,571
Wheat	1,209
Other Hydrocarbons	496
Distillate Fuel Oil	401
Metallic Salts	379
Plastic Fertilizer	293
Paper and Paperboard	148
Plastics	91
Organic comp. NEC	88
Top 10 Import Commodities*	
Crude Petroleum	69,260
Naphtha & Solvents	1,532
Distillate Fuel Oil	1,325
Lube Oil & Greases	1,301
Iron and Steel Primary Forms	744
Petroleum Coke	674
Gasoline	521
Limestone	314
Ammonia	172
Pulp and Wastepaper	160

Source: USACE (2003b).

*The number of short tons for each commodity represents a total of all Foreign, Canadian, Domestic-Coastwise, and Internal (inbound or outbound) tonnage for each commodity that is either an export or an import to the four study area ports.

3.14.3.4 Commercial Fishing

Commercial fishing within the Sabine Lake system is a relatively small contributor to the study area economy compared with other industry sectors. Table 3.14-16 compares the commercial fishing landings of the Sabine Lake system to all Texas bay systems in 2004. The total wholesale value for all finfish and shellfish landings in the Sabine Lake system in 2004 was $623,160. It is noteworthy, however, that 2004 was not a particularly good year for commercial fishing in the Sabine Lake system. During the 1990s, 1992 had the greatest total value for all finfish and shellfish landings at $6.0 million.

Table 3.14-16
Trends in Commercial Fishery Landings – Sabine Lake System
Compared with All Texas Bay Systems, 1999

	Sabine Lake System			All Texas Bay Systems	
	Weight (lbs) of Fish Landed	Wholesale ($) Value of Fish Landed	% of Total (lbs) From All Texas Bay System Landings	Weight (lbs) of Fish Landed	Wholesale ($) Value of Fish Landed
Black drum	0	0	0	1,717,000	1,444,000
Flounder	0	0	0	151,000	325,000
Sheepshead	0	0	0	68,000	28,000
Mullet	535	668	0.7	76,000	143,000
Other finfish	7,312	38,793	66.5	11,000	9,000
Total finfish	7,847	39,461	0.1	5,620,000	10,585,000
Shrimp, bait	0	0	0	1,330,000	3,666,000
Shrimp, commercial	344	355	<0.1	31,150,000	96,055,000
Total shrimp	344	355	<0.1	32,480,000	99,721,000
Blue crab	707,086	439,036	17.8	3,967,000	2,668,000
Eastern oyster	0	0	0	5,569,000	14,954,000
Squid	0	0	0	42,000	40,000
Total shellfish	707,430	439,371	7.4	9,578,000	17,662,000
Total finfish and shellfish	715,277	478,832	1.5	47,715,000	128,168,000

Source: TPWD (2005d).

The 2002 and 2003 Gulf annual commercial fishery statistics for Louisiana and Texas (NMFS, 2005) were reviewed. The commercial catch and the value of that catch for Louisiana were 1.3 billion pounds ($307 million) and 1.2 billion pounds ($294 million) for 2002 and 2003, respectively. The Texas catch was 93 million pounds ($173 million) and 96 million pounds ($168 million) for the same time periods. Menhaden were the dominant poundage in Louisiana, while shrimp accounted for most of the weight in Texas. Shrimp, in terms of value, were most dominant in both states. Commercial finfish catches in the Gulf result from beach seines (under certain circumstances), longlines, and incidental catch in shrimp trawls. The blue crab fishery is located in the bays as well as the Gulf. From 1982 to 1986, an annual average of 7.1 million pounds of blue crabs was landed in Texas at an annual average value of $2.8 million. More species-specific commercial catch information is located in Appendix B ODMDS, subsection 3.5.1.1.

3.14.3.5 Recreation

3.14.3.5.1 Recreational Fishing

Among sport-related activities, recreational fishing continues to be a major outdoor recreational activity. In 2006, 3.0 million people aged 16 and older fished in Texas. Between 2001 and 2006, the number of anglers increased by 25 percent, and fishing expenditures increased by 66 percent. Saltwater fishing increased by 33 percent, and freshwater fishing increased by 1 percent (USFWS, 2002e, 2006).

Sabine Lake, numerous wetlands, and the Gulf are sources of recreational fishing within the study area. The large variety of fresh and saltwater species in the area make fishing the most popular recreational activity within the marsh environment within the region. Recreational fishing in this area is a yearround activity that varies with the breeding cycle, water levels, fishing pressure, and aquatic-life productivity. Largemouth bass in inland waters and speckled trout in the Gulf and Sabine Lake are favorites among anglers in the area. Many local freshwater and saltwater anglers join fishing clubs, and enter contests for prize money. The estuarine-marsh-swamp environment provides the necessary nursery ground for an abundant seafood supply. More than 90 percent of the Gulf's finfish spend part of their lifecycle within the coastal zone. Although most species are commercially exploited, recreational anglers contributed more than $420 million to the local economy (within southeastern Texas and southwestern Louisiana) in 2006, with more than half a million people involved in this leisure time activity (USFWS, 2003).

Also, crawfish are an important source of recreational fishing within freshwater wetlands and creeks within the study area (as well as throughout Louisiana). These crustaceans are collected from natural water areas and cultivated in ponds. In Louisiana and the Louisiana portion of the study area, the crawfish is more than a source of recreational fishing or even a food supply, but rather part of the local culture. Found in almost every ditch and harvested from large ponds, crawfish are utilized as food, bait, income, recreation, weed control, and as a literary topic (Davis, 1996).

3.14.3.5.2 Wildlife-Associated Recreation

Outdoor recreation is a booming business throughout the United States, and Texas and Louisiana offer many outdoor recreational activities. According to the USFWS 2006 National Survey of Fishing, Hunting, and Wildlife Associated Recreation, 29 percent of the total population of Louisiana and 26 percent of the total population of Texas was involved in wildlife-related recreation (USFWS, 2006).

Among the 1.2 million people who participated in wildlife-related recreation in the State of Louisiana in 2006, 91 percent were involved in sporting wildlife recreation (fishing, hunting, or both) and 60 percent were involved in wildlife-watching (feeding, photographing, and observing). Among the 6.0 million people who participated in wildlife-associated recreation in the State of Texas in 2006, 68 percent were involved in sporting wildlife recreation and 70 percent were involve in wildlife-watching (USFWS, 2006).

One of the benefits of outdoor recreation is the economic impact it has on a state and its regions. In Louisiana, over $2.0 billion was spent on wildlife-associated activities (sporting yielded over $1.7 billion and wildlife-watching yielded over $312 million), and in Texas, almost $2.3 billion was spent on wildlife-associated activities (sporting yielded almost $1.3 billion and wildlife-watching yielded almost $2.9 billion) (USFWS, 2006).

The Big Thicket National Preserve covers 106,684 acres of wetland, riparian and upland forest habitat within portions of Hardin and Orange counties, Texas, in the vicinity of the study area. It has been referred to as an "American Ark" because of the tremendous amount of biological diversity that occurs there. Recreational activities include auto touring, backpacking, biking, birdwatching, boating, camping, fishing, hiking, horseback riding, hunting, interpretive programs, kayaking, nature walks, stargazing, swimming, and wildlife viewing. As a major recreational attraction of the area, the Big Thicket received 106,237 visitors in fiscal year 2004. The annual budget has decreased from $2,266,000 in fiscal year 2002, to $2,251,000 in fiscal year 2004 (USFWS, 2003). As with most attractions, money spent in the Big Thicket area would move into local economies. Many visitors to the Big Thicket National Preserve come as weekend visitors from the Houston metro area, and most visitors to the preserve spend money within the BPA MSA and the Lake Charles MSA (within the study area) on hotels, restaurants, entertainment, groceries, supplies, and sporting equipment. The popularity of outdoor recreation and "eco-tourism" within the study area is expected to increase over time, and with the increase in visitors to the area, there would be an increase in visitor spending within the local economy (Helen, 2002).

3.14.3.5.3 Hunting

The economic impact of hunting in Texas resulted in $2.2 billion spent in Texas in 2006. Trip-related expenses totaled $874 million, including $338 million on food and lodging, $336 million on transportation, and $785 million for equipment rental. Hunting within the Louisiana portion of the study area is equally popular, with numerous seasonally occupied camps located primarily on private land, and leased to club members who often travel from metropolitan areas of Louisiana and Texas to waterfowl and deer hunting, among other game. Spending on hotels, restaurants, groceries, entertainment, supplies, and sporting goods by these hunting recreationists is a boon to both the economies of the BPA MSA and the Lake Charles MSA and is expected to increase over time as an important economic contributor (Helen, 2002).

In 2001, 6 percent of the U.S. population aged 16 and older were involved in hunting activities. An average of 18 days was spent by each hunter on their sport. The USFWS reports that the number of hunters has dropped by 7 percent between 1991 and 2001. The drop occurred primarily in small game and other animal hunting. Big game and migratory bird hunting numbers remained constant. Hunting-related expenditures also dropped by 12 percent. Neither the drop in hunters nor the drop in their expenditures is considered statistically significant (USFWS, 2002e).

3.14.3.5.4 Wildlife Watching

In 2006, 24 percent of the U.S. population aged 16 and older were involved in wildlife-watching activities. Between 2001 and 2006, people involved in wildlife-watching activities decreased by 7 percent. The USFWS differentiates between wildlife-watchers who participate around their homes and those who take trips to view wildlife. In spite of the decrease in the population of wildlife-watchers, their total expenditures have increased over the last 5 years by 16 percent, primarily due to equipment expenditures (USFWS, 2002e, 2006).

In 2006, expenditures related to wildlife-watching in the State of Louisiana were almost $312 million, and in the State of Texas were almost $2.9 billion. Expenditure totals include food and lodging, transportation, equipment, magazine subscriptions, membership dues, and contributions (USFWS, 2002e).

Wildlife-watching, particularly birding, is an extremely popular activity within the study area and in the nearby vicinity. The Great Texas Coastal Birding Trail (GTCBT) is a series of trails that links 308 bird-watching sites and many communities within 43 Texas counties on or near the Gulf Coast. The GTCBT offers boardwalks, parking pullouts, kiosks, and observation platforms for the comfort of wildlife-watchers. Participation in the GTCBT has grown by 33 percent overall between 2001 and 2002. Participation by youth teams has grown from one team to 97 teams in the 7 years of its existence (Scroggs, 2002; USFWS, 2002e).

There are several sections of the GTCBT that are located in or near the project study area. They are: Claiborne West Park, Lower Neches WMA and Bailey's Fish Camp, Big Thicket National Preserve, Gore Store Road and Turkey Creek, Roy E. Larson Sandyland Sanctuary, Village Creek State Park, Tyrrell Park and Cattail Marsh, Tony Houseman State Park and WMA, Pleasure Island, J.D. Murphree WMA, Taylor Bayou, Sabine Pass, Sabine Pass Battleground State Historic Park and Texas Point, Texas Point NWR, Sabine Woods, Sea Rim State Park, and McFaddin NWR.

3.14.3.6 Tax Base

In Texas the state sales tax is 6.25 percent, with local sales/use tax not to exceed 8.25 percent (Texas Comptroller of Public Accounts, 2009). In Louisiana the aggregate rate of state sales tax is 4.00 percent, which consists of 3.97 percent Louisiana sales tax and 0.03 percent Louisiana Tourism Promotion District sales tax (Louisiana Association of Tax Administration, 2008). Within the general vicinity of the study area, local sales/use taxes are as shown in Table 3.14-17.

Table 3.14-17
Sales and Use Taxes by Study Area Jurisdictions, 2004*

Taxing Jurisdiction	City Rate (%)	County/Parish Rate (%)	Total Rate (includes State sales/use tax %)
City of Beaumont	1.25	0.50	8.25
City of Port Arthur	1.25	0.50	8.25
City of Port Neches	1.25	0.50	8.25
City of Groves	1.25	0.50	8.25
City of Nederland	1.25	0.50	8.25
City of Bridge City	1.25	0.50	8.25
City of Orange	1.25	0.50	8.25
City of West Orange	1.25	0.50	8.25
City of Vidor	1.25	0.50	8.25
City of Lake Charles	2.25	2.25	8.75

Source: Texas Comptroller of Public Accounts (2005a, 2005b); Louisiana Department of Revenue (2005); Louisiana Economic Development (2005).

*2002 for Louisiana.

In Texas property is appraised, property tax is collected by local (county) tax offices or appraisal districts, and these funds are used to fund many local needs including public schools, city streets, county roads, police, and fire protection (Texas Comptroller of Public Accounts, 2009). In Louisiana property is appraised, property tax is collected by local (parish) tax offices or Police Juries, and these funds are used for local schools and services. Table 3.14-18 provides a summary of property tax jurisdictions and tax rates for jurisdictions that affect large portions of the population living in the vicinity of the study area.

3.14.4 Land Use

The study area is approximately 1,900 square miles in area, and includes portions of Jefferson, Hardin and Orange counties, Texas, and Calcasieu and Cameron parishes, Louisiana. The study area includes nine municipalities: Beaumont, Port Neches, Nederland, Groves, Port Arthur, Bridge City, Vidor, Orange, and West Orange. Land uses for portions of the study area that are relatively close to the detailed study area are shown on figures 3.14-3a (Beaumont, Vidor, and vicinity), 3.14-3b (Nederland, Groves, Port Neches, Port Arthur and vicinity), and 3.14-3c (Sabine Pass and vicinity).[2]

The most currently available coverages were obtained from a variety of public agencies and private entities, and were integrated into a GIS using ArcView 3.2 and ArcView GIS. A land use/land cover coverage for the study area in 1990 was obtained from the USGS. This coverage was developed by the USGS through interpretation of satellite imagery (USGS, 1990). This land use/land cover coverage uses the Anderson system of classification, which categorizes land uses into 19 categories. Also, 1999 TxDOT county roads coverage (TxDOT, 1999a) and a 1999 parks coverage (derived from the TxDOT urban data) were obtained from Texas Natural Resource Inventory System (TxDOT, 1999b). Additional state parks and wildlife management areas (GLO, 1997) and wildlife refuge coverages (USFWS, 2001) for Texas were obtained from the GLO and USFWS. In addition, 1999 road and park coverages were obtained from the Louisiana Oil Spill Coordinator's Office for Cameron and Calcasieu parishes. A combination of these coverages was used as a working base map for aerial interpretation.

Within the study area, new urban development had occurred since 1990, so the land use/land cover coverage did not adequately capture areas of development since 1990. In order to address this issue, land use interpretation was conducted from working maps to identify and categorize land uses from areas that had been developed since 1990. Land use observations taken from a windshield survey of the study area, on October 2 and 3, 2001, were used to verify interpretation from the land use working maps. These new land use polygons were digitized and combined with the existing USGS land use/land cover coverage. In addition, the Anderson system of classification categories were aggregated for display in order to focus on urban land uses rather than vegetation types.

The study area includes all of Sabine Lake and portions of the Sabine and Neches rivers (flowing into Sabine Lake). The land use figures show the detailed study area that consists of the proposed areas for channel deepening within a 1-mile corridor and includes portions of land adjacent to the channel. The

[2]Land use maps were developed for portions of the study area that are relatively close to the detailed study area, because these are the areas where potential effects (either beneficial or adverse) from project implementation may accrue to the local population.

Table 3.14-18
Property Tax Role for Study Area Jurisdictions

Tax Jurisdictions	Tax Rate per $100 of Appraised Valuation	Tax Jurisdictions	Tax Rate per $100 of Appraised Valuation
Jefferson County, Texas		Orange County Lateral Roads	0.00649
Jefferson County	0.365	Orange County Navigation and Port District	0.0125
Hamshire Fannett ISD	1.325	Orange County Drainage District	0.12111
Beaumont ISD	1.1925	Bridge City ISD	1.66320
Nederland ISD	1.12	Little Cypress-Mauriceville CISD	1.6
Port Arthur ISD	1.3111	Orangefield ISD	1.585
Port Neches-Groves ISD	1.284	Vidor ISD	1.64250
Sabine Pass ISD	1.134808	West Orange Cove CISD	1.57357
City of Beaumont	0.6400	City of Bridge City	0.58850
City of Groves	0.624207	City of Orange	0.846
City of Nederland	0.578	City of Port Arthur	0.775
City of Port Arthur	0.76	City of Pinehurst	0.42
Port of Sabine Pass	0.194148	City of Rose City	0.17318
Drainage District #3	0.304615	City of Vidor	0.561
Drainage District #6	0.195587	City of West Orange	0.42939
Drainage District #7	0.13965	Orange Co. Water Control and Improvement District	0.36412
Navigation District	0.022418	Orange Co. Emergency Services District #1 (Vidor)	0.1
Water District #10	0.244705	Orange Co. Emergency Services District #2 (Bridge City)	0.1
Emergency Services District #1	0.026726	Orange Co. Fire District #3 (Little Cypress)	0.03
Emergency Services District #2	0.049721	Orange Co. Fire District #4 (McLewis-Mrcville)	0.03
Hardin County, Texas		**Calcasieu Parish, Louisiana**	
Hardin-Jefferson ISD	1.485	City of Lake Charles	2.25
West Hardin ISD	1.69	Calcasieu Parish Police Jury	2.25
Kountze ISD	1.5	Calcasieu Parish School Board	2.00
Lumberton ISD	1.456	City of Iowa	2.50
Silsbee ISD	1.62	City of Vinton	2.50
Lumberton MUD	0.18428	City of Westlake	2.50
City of Silsbee	0.37	**Cameron Parish, Louisiana**	
City of Kountze	0.45	Parishwide	0.00372
City of Sour Lake	0.45	Parishwide Road	0.00661
City of Rose Hill	0.057742	Courthouse	0.00264
Silsbee Fire #2	0.03	Library	0.006
Batson Fire #4	0.03	Mosquito	0.00563
Saratoga EMSD #3	0.07	Consolidated Garbage #1	0.00786
Kountze EMSD #1	0.05	Law Enforcement	0.01141
Lumberton EMSD #2	0.08	Law Enforcement Special	0.01
Sour Lake EMSD #5	0.048949	Assessment District	0.00271
Orange County, Texas		Combined School District	0.05072
Orange County	0.53913		

Source: Hardin County Tax Appraisal District (2008); Jefferson County Tax Appraisal District (2008); Orange County Tax Appraisal District (2008); Calcasieu Parish School System Sales and Use Tax Department (2008).

ISD = Independent School District; CISD = Consolidated Independent School District; MUD = Municipal Utility District; EMSD = Emergency Services District.

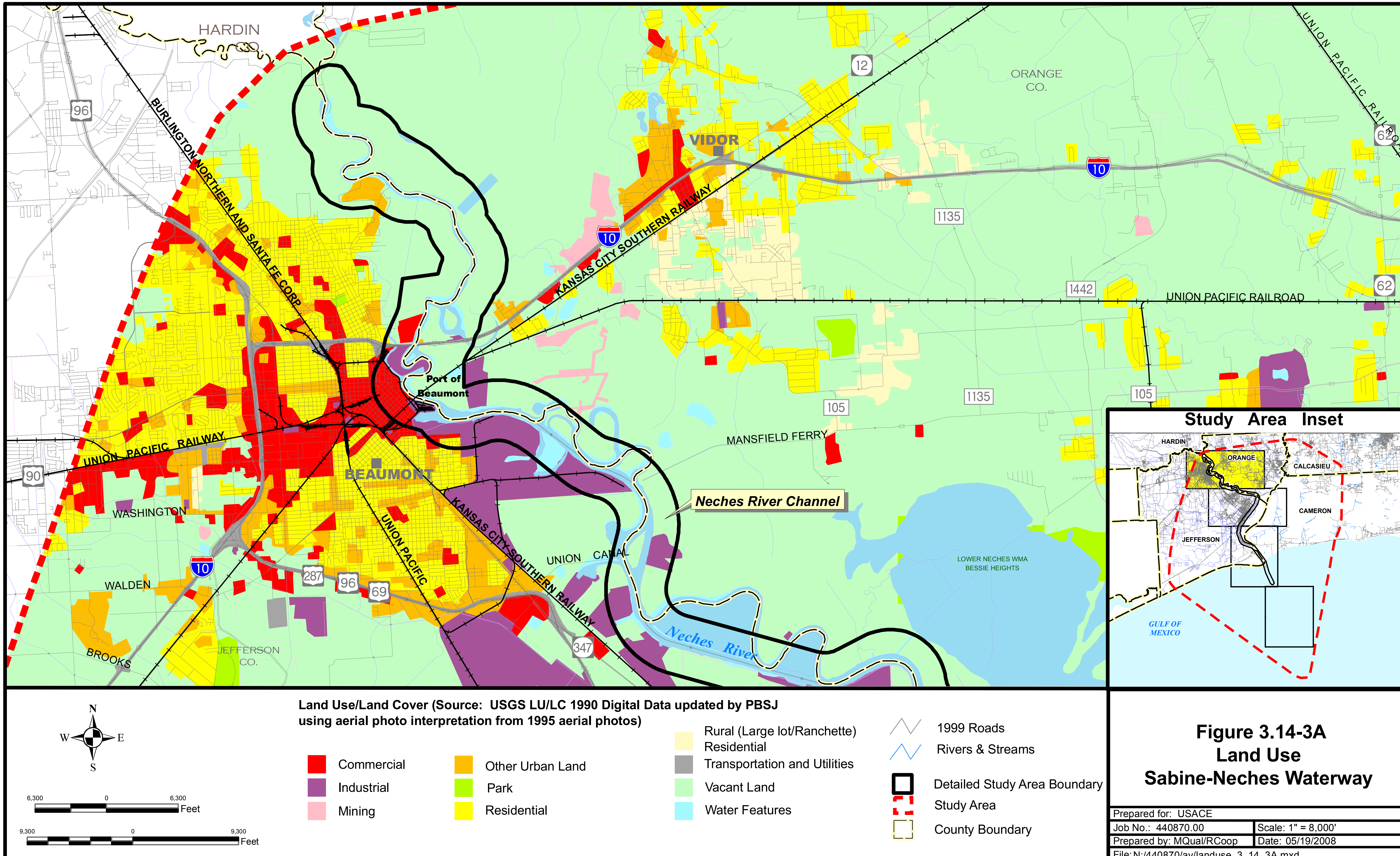

Figure 3.14-3A
Land Use
Sabine-Neches Waterway

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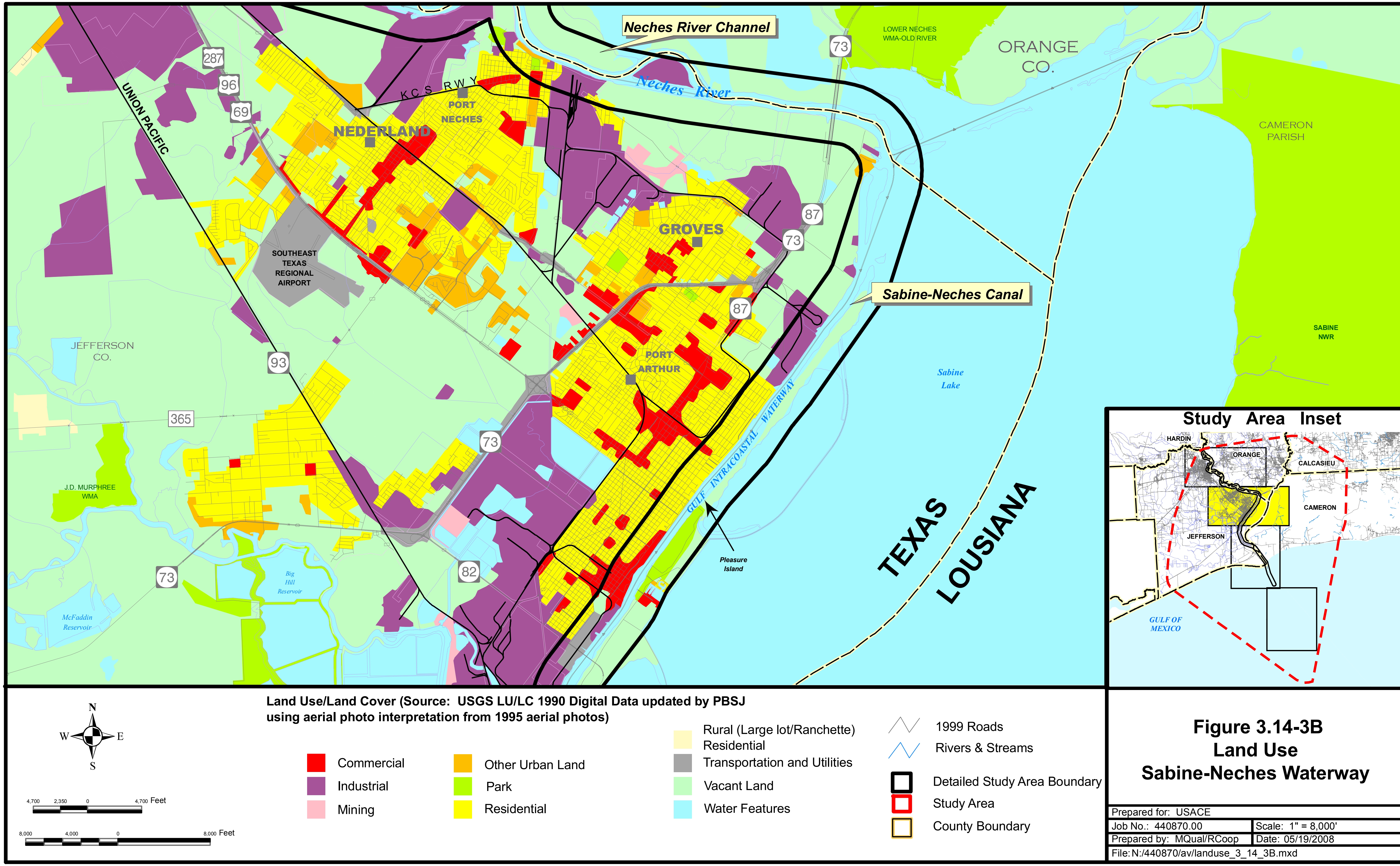

Figure 3.14-3B
Land Use
Sabine-Neches Waterway

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Land Use/Land Cover (Source: USGS LU/LC 1990 Digital Data updated by PBSJ using aerial photo interpretation from 1995 aerial photos)

- Commercial
- Industrial
- Mining
- Other Urban Land
- Park
- Residential
- Rural (Large lot/Ranchette) Residential
- Transportation and Utilities
- Vacant Land
- Water Features

- 1999 Roads
- Rivers & Streams
- Project Area, Proposed Channel
- County Boundary

N W E S

8,000 4,000 0 8,000 Feet

1 0.5 0 1 Miles

Figure 3.14-3C
Land Use
Sabine-Neches Waterway

Prepared for: USACE
Job No.: 100007609 | Scale: 1" = 8,000'
Prepared by: 18895 | Date:07/09/2009
File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/landuse_3_14_3C.mxd

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detailed study area is divided into the following subcategories: the Neches Channel, the Sabine-Neches Channel, the Port Arthur Channel, the Sabine Pass Channel, and the Sabine Pass Jetty Channel. Cities that are located adjacent to the detailed study area include Beaumont, Port Neches, Nederland, Groves, Bridge City, and Port Arthur.

As shown on Figure 3.14-3a, the City of Beaumont is located along the IH 10 corridor and along the western banks of the Neches Channel. Beaumont's downtown central business district (CBD) is located immediately west of the Neches Channel, and includes a variety of land uses including restaurants, retail shops, civic buildings, museums, hotels, and apartment buildings. The Beaumont CBD area includes the Art Museum of Southeast Texas, the Texas Energy Museum, the Jefferson County Courthouse, the Beaumont Civic Center, the Edison Plaza Museum, the Riverfront Park, the Fire Museum of Texas, and various other City of Beaumont and Jefferson County facilities. The Port of Beaumont is located on the southeast side of the CBD (at the intersection of Main Street and Blanchette Street) adjacent to the Neches Channel. Industrial sites in the Beaumont area are located adjacent to the Port of Beaumont along the Neches Channel, and to the southeast of the Beaumont city limits. Industrial uses in this area include Trinity Industries, ExxonMobile, Mobile Chemical, and North Star Steel.

Located east of Beaumont and along IH 10 is the City of Vidor. Vidor is a relatively small town with commercial uses located mainly along the IH 10 corridor. Residential neighborhoods of Vidor extend both north and south of the IH 10 corridor.

The City of Nederland is located southeast of Beaumont along the US Highway 287 corridor. This city is mostly residential in character with some commercial areas and parks. Industrial uses are located adjacent to Nederland to the north.

The City of Groves is located north of Port Arthur along SH 73. This relatively small city is mostly residential in nature and is bordered by heavy industrial uses to the northwest, north, northeast, and east.

Located along the southwest side of the Neches Channel is the City of Port Neches. This city includes older residential neighborhoods (located mostly near the Port Neches CBD), new subdivisions (mostly located on the southwest side of the city and near SH 347), commercial development along state highways and arterial roadways, and some civic buildings located mostly in the CBD. Industrial uses are located west and east of the city limits and along the Neches Channel. Notable industrial uses located to the west of Port Neches include Huntsman, Ameripol Synpol/Huntsman, Motiva Enterprises, and Air Liquide. Adjacent to the Neches River on the north side (north of Port Neches), land uses are mostly vacant land, with the exception of the Entergy – Sabine Plant.

North of the Sabine Pass area, the SNWW divides Pleasure Island and Sabine Lake from land areas west of the channel. Pleasure Island is a long narrow island that extends from the Sabine Pass area northward to the vicinity of the confluence of the Sabine and Neches rivers. The southern half of Pleasure Island consists primarily of vacant land. The northern half of Pleasure Island has some development in areas directly across from downtown Port Arthur. These developed areas consist of the Port Arthur Marina and

Yacht Club, the Pleasure Island Golf Course, Logans Park, City Hall Park, residential areas, and buildings and facilities operated by the USCG, the U.S. Army Reserve, the USACE, and Lamar University. SH 82 (T.B. Ellison Parkway) provides north-south access along Pleasure Island.

West of Pleasure Island and the Sabine-Neches Ship Channel is the City of Port Arthur. This area is characterized by heavy industry south, southwest, and north of the city. Land uses in the City of Port Arthur include commercial development mostly along state highways and arterial roadways, and residential neighborhoods, offices, and parks are interspersed throughout the city on collector and residential streets. Housing stock varies widely in terms of date of construction, size, and degree of maintenance. Civic buildings are located mostly in Port Arthur's CBD, which is located near the Sabine-Neches Ship Channel. Also located in the Port Arthur CBD is Lamar University – Port Arthur, and the Port of Port Arthur.

Notable industrial uses located east, southeast, and south of Port Arthur include Motiva Enterprises LLC, Huntsman, Ethyl Additives, Equilon, Premcor, Chevron, and the Texaco Terminal. Notable industrial uses that are located north of Port Arthur include Atofina, Horizon, Pabtex, R&R Marine Maintenance, and a variety of other industrial companies located either along SH 87/73 or adjacent to the SNWW.

Sabine Pass forms the southern entrance of the Sabine-Neches Ship Channel from the Gulf into the study area. In this area, on the Texas side (on the west side) of the Sabine Pass, is the Texas Point NWR and the Sabine Pass Battleground State Historical Park. Farther west along the Gulf coastline is Sea Rim State Park and the McFaddin Marsh NWR. This area is characterized by (mostly) undeveloped marshland and beaches, with numerous small lakes and wetland areas. The eastern side of Sabine Pass (the Louisiana side) consists almost entirely of undeveloped marshland and beaches. SH 82 parallels the Gulf coastline and connects with Johnson's Bayou, Holly Beach, Cameron, and the Calcasieu Lake area to the east.

In Louisiana, east of Sabine Lake, land is mostly vacant and consists primarily of wetland areas. The Sabine NWR makes up much of the land area in this portion of Cameron Parish. Very few roads or other urbanized land uses are located in this area.

3.14.4.1 Transportation

3.14.4.1.1 Roadways

Surface transportation in the vicinity of the study area is provided by a network of primary, secondary, and local roads. IH 10 is the primary artery of the BPA MSA. US 69, 90, and 287 and SH 347 also facilitate travel throughout the study area. As a result of the area's heavy dependence on industrial manufacturing, rail and sea transportation are vital within the area.

Transportation in Cameron Parish is served by two major state highways. The major north-south routes through the parish follow SH 27, which connects with IH 10 in Calcasieu Parish (16 miles north of the Cameron Parish border). The major east-west route through the parish is SH 82, which follows the Gulf Coast. Traffic on SH 27 and SH 82 must use the Cameron Ferry to cross the Calcasieu River Ship

Channel. Intercity bus service is provided only in Lake Charles and in Sulphur (Cameron Parish Police Jury, 2002). In Cameron Parish, IH 10 provides for east-west travel through the parish. SH 171 provides for travel to points north of Lake Charles.

3.14.4.1.2 Airports

There are no public general or commercial aviation airports in Cameron Parish. There are several private companies that have landing strips and offer helicopter services (primarily to the offshore oil and gas industry).

The Southeast Texas Regional Airport is located 10 miles south of Beaumont on US 69. This airport is served by Continental Express providing direct service to Houston and Dallas-Fort Worth. The Orange County Airport, located 3 miles southwest of Orange, serves general aviation needs for the study area. The Beaumont Municipal Airport serves the City of Beaumont and is located on US 90, 6 miles west of the city.

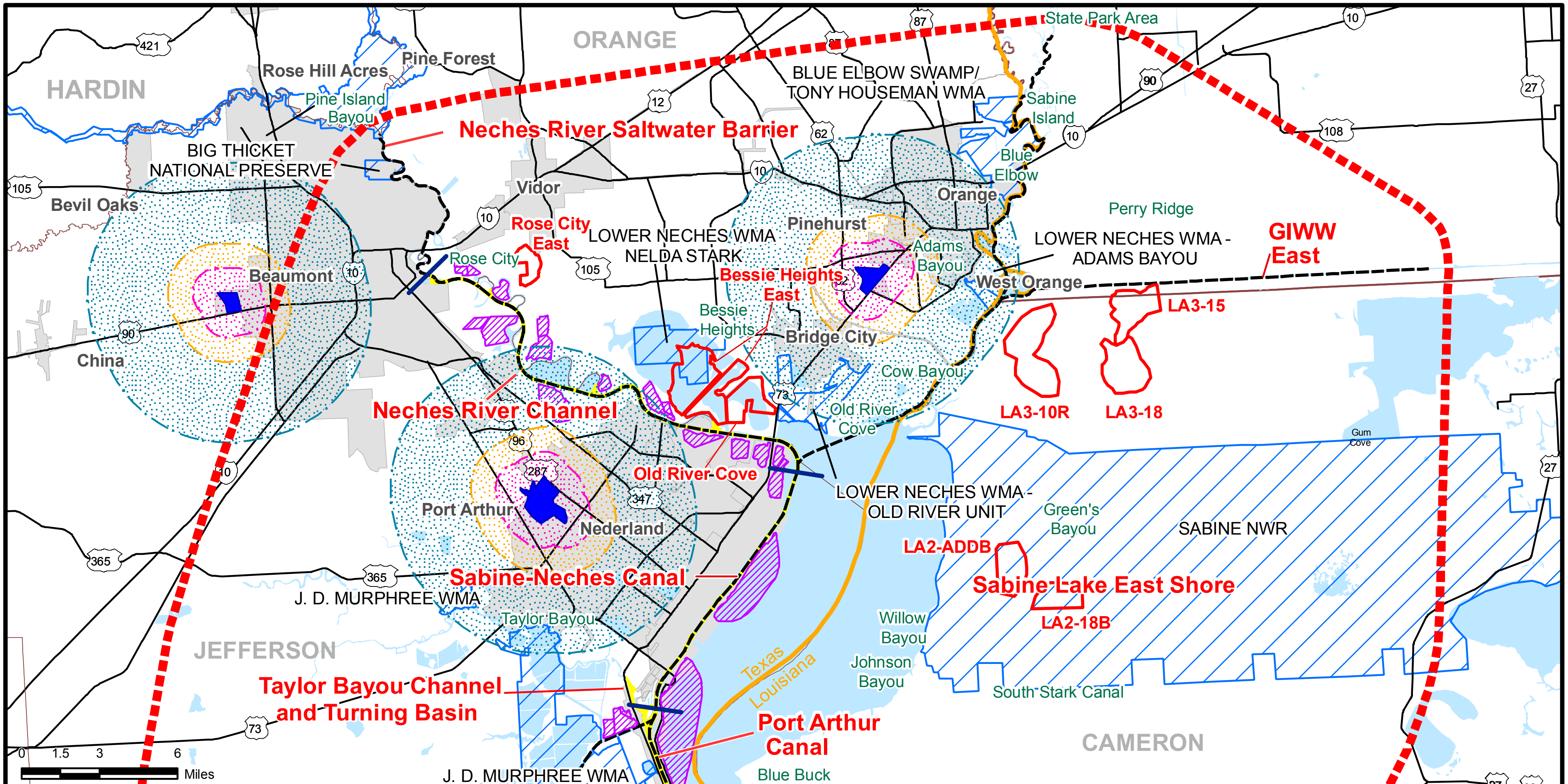
Due to the increasing concern about aircraft-wildlife strikes, the FAA has implemented standards, practices, and recommendations for holders of Airport Operating Certificates issued under Title 14, CFR Part 139, Certification of Airports, Subpart D (Part 139), to comply with the wildlife hazard management requirements of Part 139. Airports that have received Federal grant-in-aid assistance must use these standards.

When considering proposed dredged spoil, BU features, and mitigation areas, developers must take into account whether the proposed action will increase wildlife hazards. The FAA recommends minimum separation criteria for land use practices that attract hazardous wildlife to the vicinity of airports. These criteria include land uses that cause movement of hazardous wildlife onto, into, or across the airport's approach or departure airspace or air operations area (AOA).

These separation criteria include:

- Perimeter A: For airports serving piston-powered aircraft, hazardous wildlife attractants must be 5,000 feet from the nearest AOA (does not include any of the three airports within the study area);
- Perimeter B: For airports serving turbine-powered aircraft, hazardous wildlife attractants must be 10,000 feet from the nearest AOA (includes the three airports within the study area); and
- Perimeter C: 5-mile range to protect approach, departure, and circling airspace (includes the three airports within the study area).

Airports within the study area that must comply with these standards include the Orange County and Southeast Texas Regional airports and the Beaumont Municipal Airport, which is located just outside the study area (Figure 3.14-4a). Figures 3.14-4b–c show the perimeters around the AOA of 5,000 feet, 10,000 feet, and 5 miles surrounding these airports. Although the Beaumont Municipal Airport itself is not located within the study area, the 5-mile perimeter does fall within the study area (Figure 3.14-4d).



Legend

- Project Area, Dredged Channel
- State Parks, National Wildlife Refuges, and Wildlife Management Areas
- Project Area, Dredged Material Placement Areas
- Project Area, BU Features
- State Boundaries
- Channel Centerlines
- County Boundaries
- Study Area
- Channel Reach Limits
- Airport

Perimeter

- 5,000 ft
- 10,000 ft
- 5 mi

N

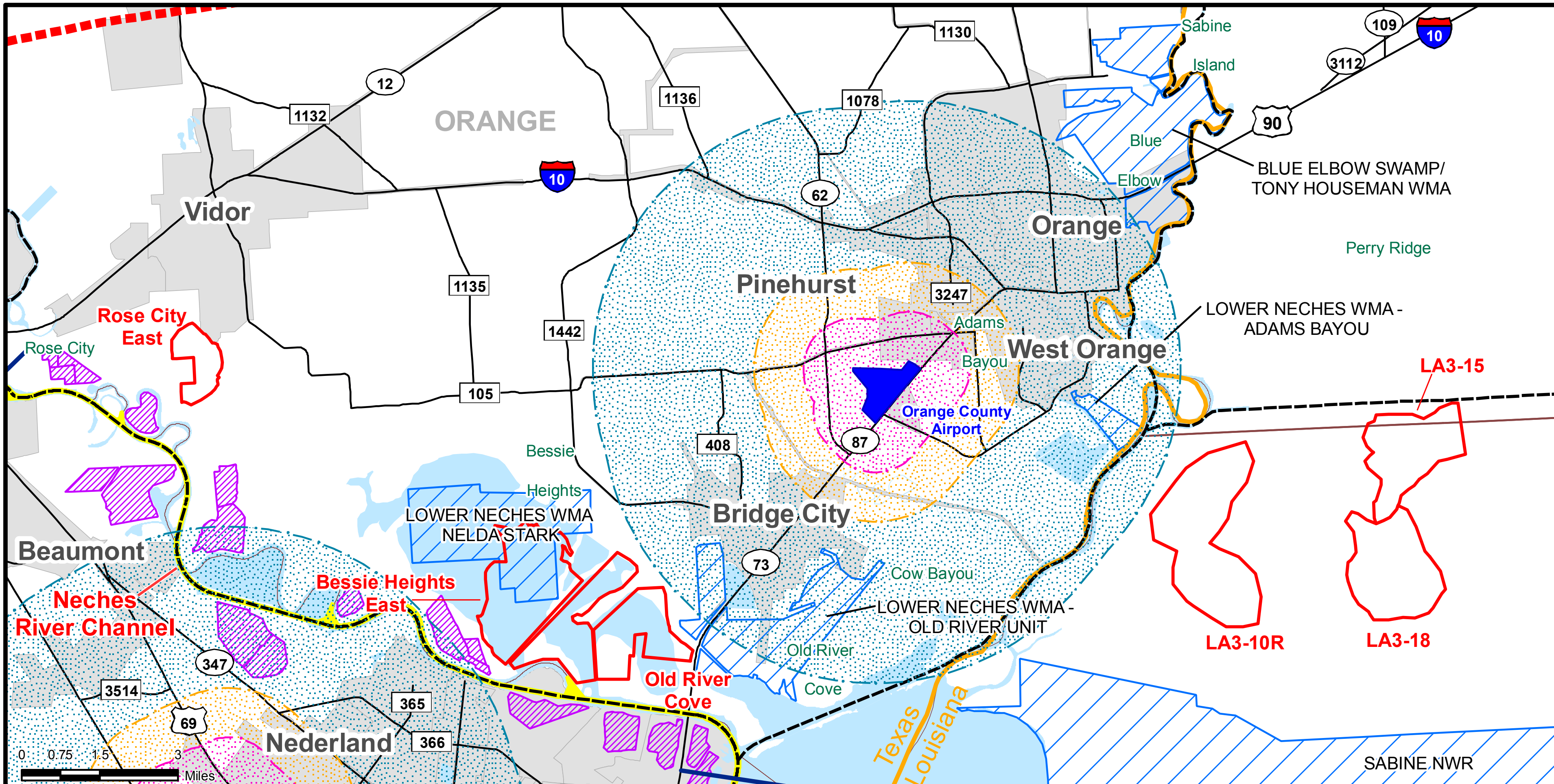
PBSJ
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 327-6840 Fax: (512) 327-2453

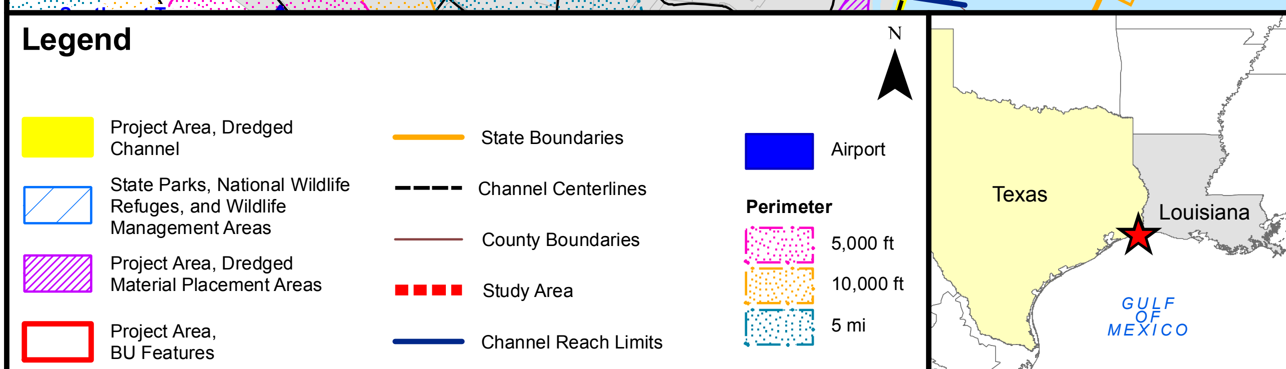
Figure 3.14-4a

Sabine-Neches Waterway Airport Locations FAA AOA

Prepared for: USACE	
Job No.: 100007609	Scale: 1 inch = 6 miles
Prepared by: RF	Date: 1 April 2010

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Fig_airport_AOA_vr3.mxd





PBSJ
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 327-6840 Fax: (512) 327-2453

Figure 3.14-4b

Sabine Neches Waterway
Orange County Airport
FAA AOA

Prepared for: USACE	
Job No.: 100007609	Scale: 1 inch = 3 miles
Prepared by: RF	Date: 1 April 2010

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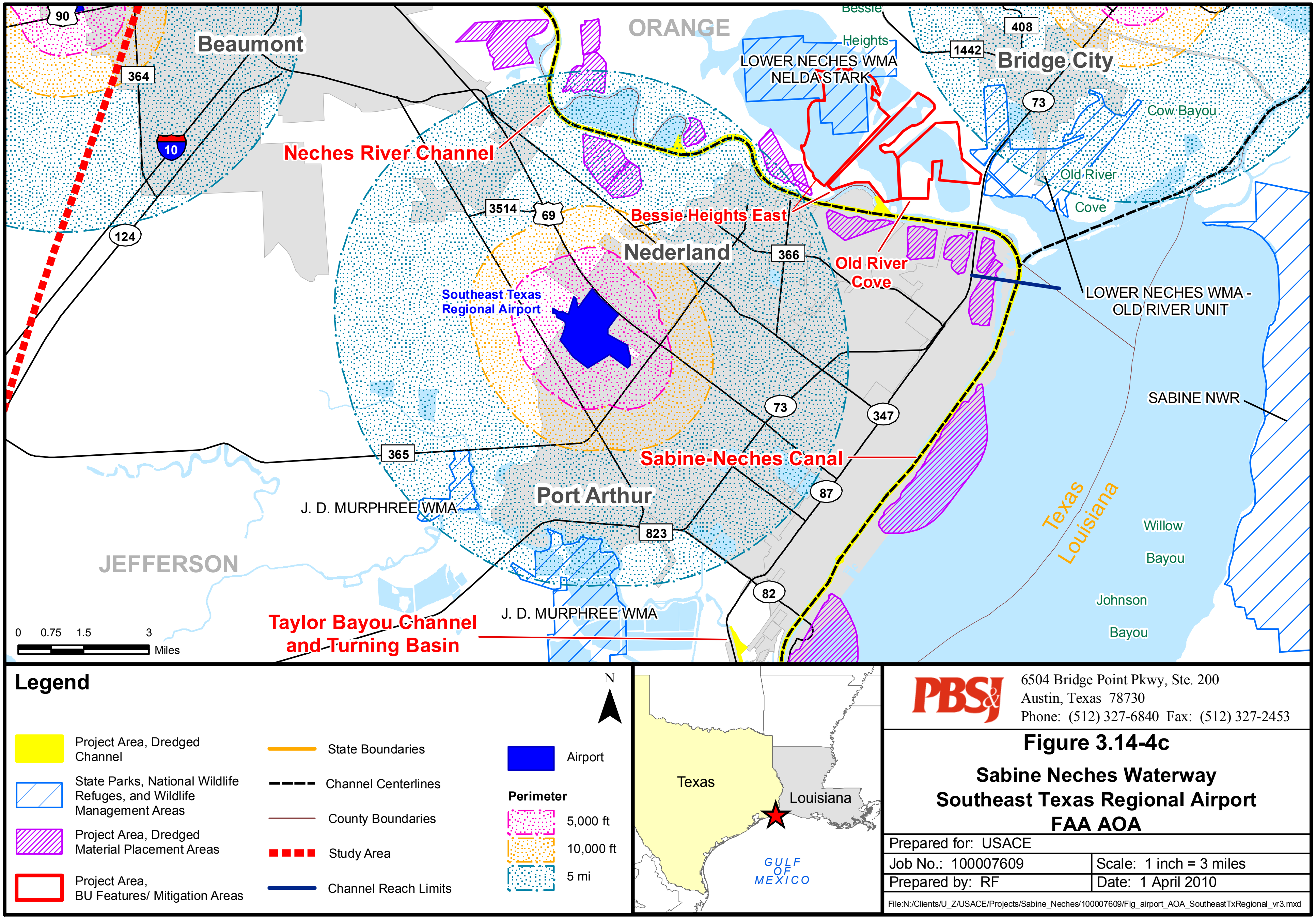
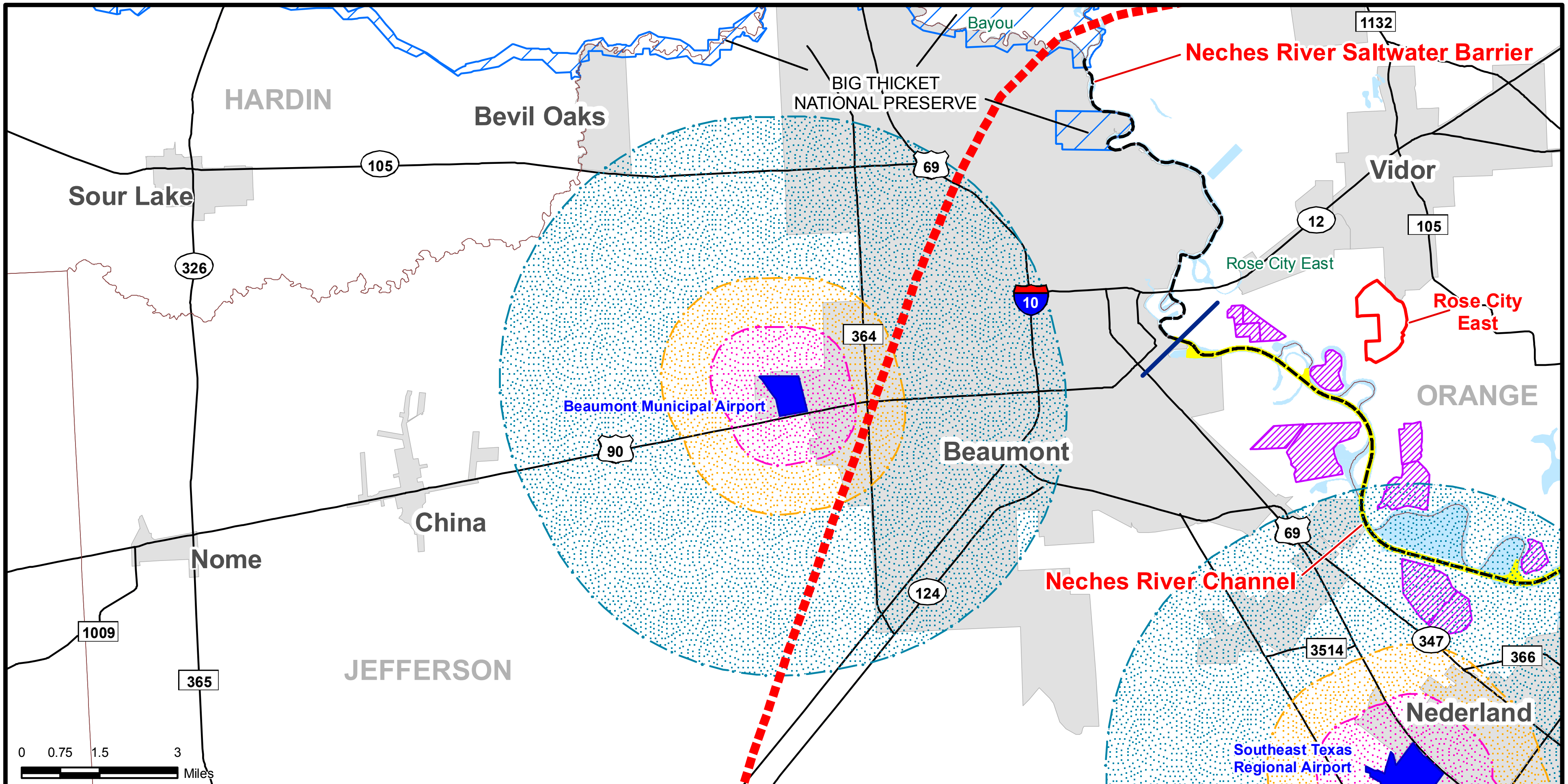


ORANGE
Beaumont
Bridge City
Nederland
Port Arthur
JEFFERSON
Neches River Channel
Bessie Heights East
Old River Cove
Sabine-Neches Canal
Taylor Bayou Channel and Turning Basin
Southeast Texas Regional Airport
LOWER NECHES WMA NELDA STARK
LOWER NECHES WMA - OLD RIVER UNIT
J. D. MURPHREE WMA
SABINE NWR
Bessie Heights
Cow Bayou
Old River Cove
Willow Bayou
Johnson Bayou
Texas
Louisiana
90
364
10
124
3514
69
366
73
347
365
87
823
82
408
1442
0 0.75 1.5 3 Miles
Legend
Project Area, Dredged Channel
State Parks, National Wildlife Refuges, and Wildlife Management Areas
Project Area, Dredged Material Placement Areas
Project Area, BU Features/ Mitigation Areas
State Boundaries
Channel Centerlines
County Boundaries
Study Area
Channel Reach Limits
Airport
Perimeter
5,000 ft
10,000 ft
5 mi
N
Texas
Louisiana
GULF OF MEXICO
PBSJ
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 327-6840 Fax: (512) 327-2453
Figure 3.14-4c
Sabine Neches Waterway
Southeast Texas Regional Airport
FAA AOA
Prepared for: USACE
Job No.: 100007609
Scale: 1 inch = 3 miles
Prepared by: RF
Date: 1 April 2010
File:N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Fig_airport_AOA_SoutheastTxRegional_vr3.mxd



Legend

N

- Project Area, Dredged Channel
- State Parks, National Wildlife Refuges, and Wildlife Management Areas
- Project Area, Dredged Material Placement Areas
- Project Area, BU Features
- State Boundaries
- Channel Centerlines
- County Boundaries
- Study Area
- Channel Reach Limits
- Airport

Perimeter

- 5,000 ft
- 10,000 ft
- 5 mi

PBS&J
6504 Bridge Point Pkwy, Ste. 200
Austin, Texas 78730
Phone: (512) 327-6840 Fax: (512) 327-2453

Figure 3.14-4d
Sabine Neches Waterway
Beaumont Municipal Airport
FAA AOA

Prepared for: USACE	
Job No.: 100007609	Scale: 1 inch = 3 miles
Prepared by: RF	Date: 1 April 2010
File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/100007609/Fig_airport_AOA_BeaumontMunicipal_vr3.mxd	

3.14.4.1.3 Railways

There is no rail service to Cameron Parish. Connections to three major freight rail systems (the Kansas City Southern Railway, the Union Pacific System, and the Southern Pacific Transportation Company) can be obtained in the nearby Lake Charles/Westlake/Sulphur metropolitan area of Calcasieu Parish. Amtrack Intercity Rail Passenger service is also available in Lake Charles.

Several rail carriers provide transportation within the study area, and form an important link to the Port of Beaumont, the Port of Port Arthur, and the Port of Orange. The four major rail carriers are Burlington Northern Santa Fe, Union Pacific, Kansas City Southern Railroad, and Tex Mex Rail Road. The Sabine River and Northern is a short-line railroad running through the area. Beaumont has 13 motor freight carrier terminals and 53 general freight carriers that serve the MSA’s transportation needs (Texas A&M University, 2000).

3.14.4.2 Community Services

3.14.4.2.1 Fire, Police, and Emergency Medical Service

Fire protection within the vicinity of the study area is handled by a combination of municipal and volunteer fire departments (VFD). Fire departments serving the study area include the Beaumont Fire Department, Nederland Fire-Rescue Department (includes the Nederland VFD), Port Arthur Fire Department, and the City of Groves Fire Department.

In Beaumont, fire protection is provided by the City of Beaumont Fire Department, which covers approximately 85 square miles and serves approximately 113,400 people. There are 229 paid personnel serving the city. This fire department responds to fire, medical, hazardous material, high-rise rescue, and dive rescue emergencies. The department includes 10 fire engines, 2 aerial pumpers, 2 aerial trucks, and 3 rescue trucks (City of Beaumont, 2009).

Fire protection within the city limits of Nederland is handled by the Nederland Fire-Rescue Department, which includes the Nederland VFD. Together, the Nederland Fire-Rescue Department and the Nederland VFD serve an area of approximately 4.5 square miles and approximately 17,400 residents who live within the City of Nederland and its Extraterritorial Jurisdiction (ETJ). There are 17 volunteer firefighters, and 6 of these personnel form a 6-person specialized rescue team. This fire department has the following equipment: three pumpers/engines, one 75-foot aerial truck, and one rescue truck. These fire departments respond to both fire and medical emergencies (City of Nederland, 2009).

In Port Arthur, fire protection is provided by the City of Port Arthur Fire Department, which covers an area of approximately 142 square miles serving approximately 57,800 people. There are 105 firefighters and 7 fire stations serving the residents and industrial areas of the city. This fire department responds to fire, medical, and hazardous materials emergencies. The services of this fire department are broken into the departments of Administration, Suppression, Training, Prevention, Communications, and Maintenance. This fire department includes the following equipment: seven fire engines, one snorkel, one dive and high-angle rescue van, one hazardous materials truck, and several rescue boats (City of Port Arthur Fire Department, 2009).

Fire protection within the city limits of Groves is provided by the City of Groves Fire Department, which covers approximately 4 square miles and serves approximately 15,733 residents living within the city limits and its ETJ. The fire department responds to fire, medical, and hazardous materials emergencies. There are 14 paid firefighters and 25 volunteers operating from one fire station that is centrally located. This fire department includes the following equipment: three pumpers, one utility van, one utility pickup truck, one Chief's car, and one Assistant Fire Marshall's car (City of Groves, 2009).

The Insurance Services Office (ISO) ranks in accordance with the *Fire Suppression Rating Schedule* manual. The rankings are determined through the examination of three primary factors: the city's alerting system (i.e., 911 service and fire alarm systems) (10 percent); the fire department itself (50 percent); and the existing water system (40 percent). In Texas, the *Fire Suppression Rating Schedule* has been modified to include the following fire prevention activities: fire prevention code information, fire investigation, public fire safety education, construction code enforcement, attendance in Texas A&M's Fireman Training School, the number of certified volunteer firefighters available, and membership in the State Fire Marshall's Association or Texas Commission on Fire Protection. On the *Fire Suppression Rating Schedule* scale of 1 to 10 (1 being best), the ISO gives the City of Nederland Fire-Rescue Department a rating of 5, the City of Port Arthur Fire Department a rating of 3, and the City of Groves Fire Department a rating of 4 (Bradley, 2002).

3.14.4.2.2 Public Services and Utilities

Within the study area, a variety of entities provides electric utility, natural gas, water, wastewater, and solid waste disposal services. These services are summarized in Table 3.14-19.

3.14.4.2.3 Regional Water Planning

The TWDB has provided information pertaining to water supply, demand, and management direction for 16 Regional Water Planning Areas in Texas in the 2007 State Water Plan, Water for Texas – 2007, which was adopted by the Board on November 14, 2006. This State Water Plan document provides baseline information and planning policy related to the East Texas Region (Region I), which includes 20 counties of East Texas, including three counties (Hardin, Jefferson, and Orange) within the proposed project study area (TWDB, 2007).

The East Texas Region Planning Group identified water supply needs for 92 out of 165 water user groups in the region. The total needs by 2060 are about 1,261,320 acre-feet per year. There are 47 urban and rural municipalities and 18 irrigation and livestock user groups with needs in 2060. Estimated capital costs of recommended water management strategies for meeting needs over the 50-year planning horizon are about $613 million (TWDB, 2007).

Table 3.14-19
Public Service and Utility Providers within the Study Area

	Electric Utility Service	Natural Gas Service	Water	Waste Water	Solid Waste Disposal Service
City of Beaumont	Entergy	Reliant Entex	City of Beaumont	City of Beaumont	City of Beaumont
City of Nederland	Entergy	Reliant Entex	City of Nederland	City of Nederland	City of Nederland
City of Port Neches	Entergy	Southern Union Gas	City of Port Neches	City of Port Neches	City of Port Neches
City of Groves	Entergy	Southern Union Gas	City of Groves	City of Groves	City of Groves
City of Port Arthur	Entergy	Southern Union Gas	City of Port Arthur	City of Port Arthur	City of Port Arthur
Unincorporated areas of Jefferson County	Entergy	Southern Union Gas and Reliant Gas			
Unincorporated areas of Hardin County					
City of Vidor					
City of Bridge City	Entergy	Reliant and Entergy Entex	City of Bridge City	City of Bridge City	City of Bridge City
City of Orange			City of Orange	City of Orange	City of Orange
City of West Orange					
Unincorporated areas of Orange County	Entergy and Gulf States Utilities	Entex and United Texas Transmission			
Unincorporated areas of Calcasieu Parish	Entergy	Reliant Entex	Publicly provided by multiple water districts	Mechanical Sewer and Septic Systems	Waste Management Inc.
Unincorporated areas of Cameron Parish					

Sources: Entergy Louisiana (2002); City of Beaumont (2002); City of Bridge City (2002); City of Nederland (2005); City of Port Neches (2002); Bellard (2002); Cendercast (2002); Greater Orange Area Chamber of Commerce (2002).

The largest water user in the East Texas Region is steam electric, which accounts for 51 percent of the total demand of about 1.75 million acre-feet per year in 2060. Increases in steam-electric power generation, mining, and irrigation demands are also expected. Municipal water use for the region is projected to increase between 2010 and 2060, from about 151,000 acre-feet per year to 188,000 acre-feet per year. Five counties (including two study area counties), Angelina, Jefferson, Nacogdoches, Orange, and Smith, account for most of the total municipal use for the region in 2060. The cities (includes three study area cities) of Lufkin, Beaumont, Port Arthur, Nacogdoches, Orange, and Tyler are included in these counties. These cities would rely on increased groundwater and surface water production to meet their needs. The only unmet needs in 2060 are 3-acre-feet per year for mining and 17 acre-feet per year for municipal uses (TWDB, 2007).

3.14.4.3 Aesthetics

The term aesthetics deals with the subjective perception of natural beauty in a landscape by attempting to define and measure an area's scenic qualities. Consideration of the visual environment includes a determination of aesthetic values (where the major potential effect of a project on the resource is considered visual) and recreational values (where the location of a proposed project could potentially affect the scenic enjoyment of the area). Aesthetic values considered in this study, which combine to give an area its aesthetic identity, include:

- topographical variation (hills, valleys, etc.)
- prominence of water in the landscape (rivers, lakes, etc.)
- vegetation variety (woodlands, meadows, etc.)
- diversity of scenic elements
- degree of human development or alteration
- overall uniqueness of the scenic environment compared with the larger region

The study area consists of a variety of terrain characterized by varying levels of aesthetic quality. The topography of the area is mostly flat to gently rolling, with very few outstanding elevational changes. Natural water features within the study area include the following: Sabine Lake, the Neches River (upstream of the Neches Channel), the Sabine River (upstream from the Sabine Channel), Black Marsh Lake, Black Bayou, Cow Bayou, Old River Bayou, numerous relatively small lakes, and many wetland areas. Also, the Gulf forms the southern border of the study area. Water features that are heavily used for waterborne commerce show a high a degree of human development and alteration and include the following: the Neches Channel, the Sabine Channel, the Sabine-Neches Channel, the Port Arthur Channel, the Sabine Pass Channel, the Sabine Pass Jetty Channel, and the GIWW. Also some areas of Sabine Lake (especially on the Texas side of the lake) show a moderate degree of human development and alteration.

In general, in areas that are not urbanized, the study area exhibits a variety of vegetation types. Generalized vegetation within the study area is shown on Figure 3.9-1 and discussed in more detail in Section 3.9. Wetland areas are found surrounding Sabine Lake, along the Gulf Coast on both the Texas and Louisiana side, throughout most of the Louisiana portion of the study area and within the floodplain areas of the Sabine and Neches rivers/channels. Agricultural lands are found mostly in the western, northern, and northeastern portions of the study area. Forested or woodland upland areas are found primarily in the northern portion of the study area between the Sabine and Neches rivers.

However, the study area has also seen widespread human development, which can, depending on the type and scale, detract or add to the overall aesthetic quality (see figures 3.14-3a–c). Urban development within the study area is concentrated in and around the following municipalities: Beaumont, Nederland, Port Neches, Groves, Port Arthur, Vidor, Bridge City, West Orange, and Orange. Land uses within the urbanized areas include a variety of residential neighborhoods, commercial or CBD districts, transportation systems (highways and railways), civic uses, parks, schools, port facilities, and heavy industry areas. The single largest detraction from the aesthetics of the study area is undoubtedly the heavy industry areas. There are large areas of heavy industry located near to the detailed study area (along the SNWW) southeast of Beaumont and in areas near Port Neches, Groves, and Port Arthur.

Generally speaking, the study area is not particularly distinguished in aesthetic quality from other adjacent areas within the region, although some areas within the region lack the vast waterbodies of the study area. The landscape exhibits a generally moderate to high level of impact from human development and alteration. No designated scenic views or scenic roadways were identified from the literature review or from field reconnaissance of the study area.

4.0 ENVIRONMENTAL CONSEQUENCES

This chapter is divided into 16 sections. Section 4.1 describes how the HS and WVA models were used to evaluate project impacts. Section 4.2 discusses risk and uncertainty in the application of these models. This is followed by separate sections that discuss project impacts to each category of physical, natural, cultural, and socioeconomic resources in the SNWW study. The chapter ends with a discussion of cumulative impacts in Section 4.16.

Environmental consequences analysis of the Preferred Alternative includes the assumption that the eight Neches River Turning and Anchorage Basins (Alternative G, Table 2.3-1) are a component of the SNWW CIP.

4.1 MODELING FUTURE WITHOUT AND WITH-PROJECT CONDITIONS

The evaluation of ecological impacts to the extensive wetland habitats in the study area was performed primarily with WVA models. These models provide quantitative estimates of changes to the quality and quantity of fish and wildlife habitat in the SNWW's wetland communities. The WVA is primarily driven by salinity predictions from the HS model. Both FWOP and FWP effects must be determined using the WVA models and the differences between the two calculated in order to determine the effects of the proposed project.

The HS model is described in detail in a separate report (Brown and Stokes, 2009). In brief, the HS model is a 3-dimensional TABS-MDS code that propagates flow and salinity throughout the model domain in response to many factors (e.g., tides, Gulf boundary conditions, winds, freshwater inflows). A 3-dimensional simulation was employed in the navigation channels and Sabine Lake, and 2-dimensional simulation (vertically integrated) was used in the shallow tributaries.

As described in Brown and Stokes (2009), the HS model was calibrated and verified using field observations collected by the ERDC during a long-term data collection effort at 16 stations in the study area from May 16, 2001, through January 10, 2002 (Fagerburg, 2003). The model tidal elevations, discharge measurements, current velocities, and salinities were compared to field data obtained during the period, and figures showing these comparisons can be reviewed in Brown and Stokes (2009). In general, the model performed reasonably well. The tidal elevations were comparable to field data near the coast with the level of agreement reduced somewhat in the upper reaches. Discharge and current velocity observations were also similar to model output at most but not all stations. The salinity comparisons were also reasonably close. It was noted that while salinity stratification was qualitatively correct, the model was somewhat more diffusive than observed and the amount of upstream salinity transport may at times be underestimated. However, a sensitivity analysis was conducted to investigate how well the model behaves under conditions when the flow is not changing rapidly. Since flow changes associated with the project would not be rapid, the behavior of the model under these conditions provides a better reflection of the gradual changes expected with the project. The model was found to behave better at most gages under these conditions. Overall, the model provides a very detailed representation of the system and appears to be a suitable tool for evaluating project effects.

With the model developed and performance demonstrated against field data, the next step was using the model to quantify changes in the FWP and FWOP conditions. Two key components of this future evaluation are freshwater inflows and relative sea level change. After these components are described, the FWOP and FWP conditions are presented.

4.1.1 Freshwater Inflows

Freshwater inflow for the SNWW HS model's future conditions were developed using model outputs from Run 8 of the TCEQ Water Availability Models (WAM) for the lower Sabine and Neches rivers. For existing conditions, "Run 8 uses modified diversion amounts (maximum use for the last 10 years), year 2000 area-capacity parameters for major reservoirs, and assumed return flows. It also includes term water rights and provides the most realistic assessment of current streamflow conditions" (TWDB, 2007). The TWDB projected flows for the year 2060 by modifying Run 8 "to include projected increased demand from existing water rights, expected change to return flows, projected new strategies to come online before 2060, and estimated year 2060 storage capacities for major reservoirs" (TWDB, 2007).

The 2060 WAM runs were selected for use in the SNWW HS modeling because they were developed by the State's lead water planning agency, and they include future water supply strategies approved by the 2007 Texas State Water Plan (TWDB, 2007). The SNWW study area is included in Regional Plan I for the East Texas Region. The Region I water plan takes into consideration existing flows that are dedicated to the State of Louisiana as prescribed by the Sabine River Compact. All existing and proposed future strategies for meeting Texas's demand must be met by the Texas firm-yield share (750,000 acre-feet) of the total Sabine River flow, as appropriated under the use provision of Certificate of Adjudication No. 05-4658 (March 5, 1958). The 2060 WAM model does not attempt to predict future demand in the Louisiana portion of the Sabine Basin. This should not significantly affect future projections because the Louisiana portion of the basin is comprised primarily of undeveloped, coastal wetlands.

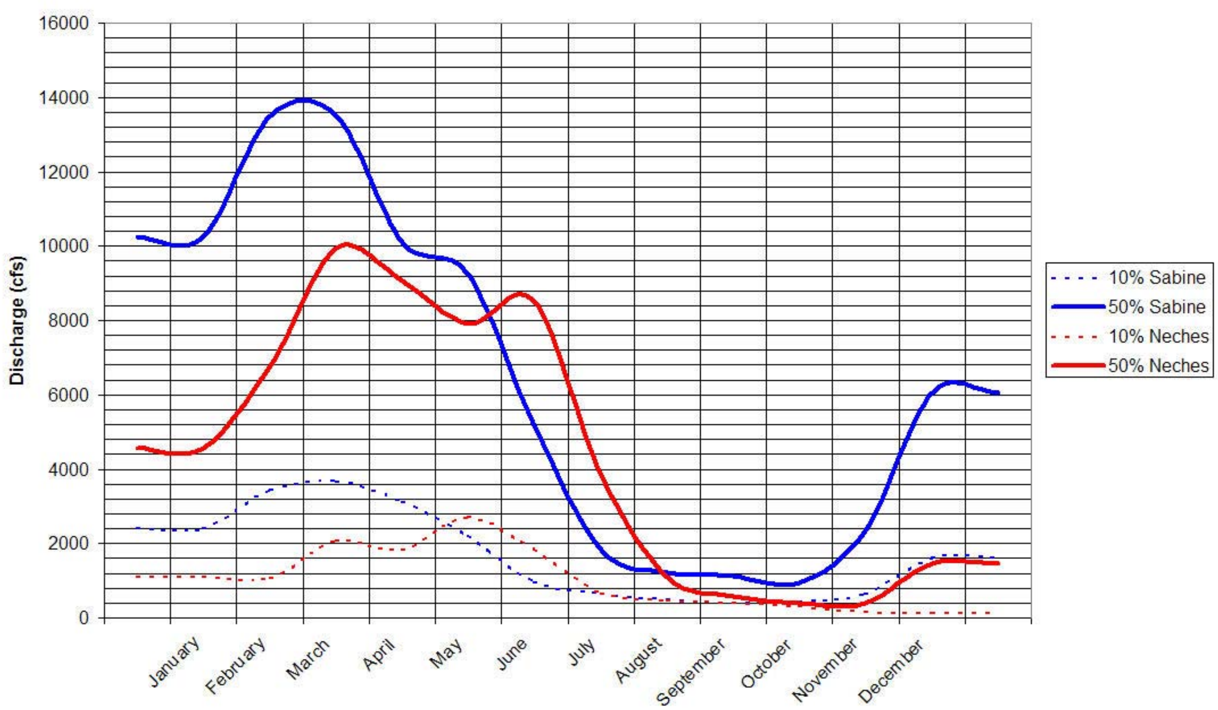
By 2060, Region I's population is projected to grow 36 percent, and water demands are projected to increase by 41 percent. The greatest increase (48 percent) is expected in the demand for water for manufacturing. Municipal demand is expected to grow 24 percent. The existing water supply is projected to decrease slightly by 2060, due primarily to reservoir sedimentation and a small decline in groundwater supply. Although the region as a whole appears to have enough supply to meet demands through 2060, the total water supply is not readily available to all users.

The regional plan recommends the following strategies to provide the additional water supply projected to be needed by 2060: (1) the construction of Lake Columbia reservoir in the Neches River watershed; (2) cooperation with Region C, which includes the Dallas-Fort Worth metropolitan area, in the use of surface water from Toledo Bend Reservoir and proposed Lake Fastrill; (3) expanded groundwater use by smaller communities; and (4) municipal conservation throughout the region.

The WAM outputs were developed using current patterns of precipitation and evaporation. The USACE did not modify the models to use projected precipitation or evaporation for SNWW future conditions because the Texas State Climatologist has recently concluded that it is impossible to predict with confidence what precipitation trends would be in Texas over the next half century (Nielsen-Gammon, 2009). Unlike precipitation, there is more consensus for a predicted temperature increase in Texas of close to 4°F by 2060. No attempt was made to change future temperatures in the model because resulting changes in evapotranspiration would be so small as to negligibly change modeling results.

Two freshwater inflow conditions, median and low, were developed for project evaluation. For both flow conditions, the ERDC provided salinities for all model stations and nodes for WVA modeling. Figure 4.1-1 illustrates the inflow values employed for the two major inflow sources for both the 10th percentile, low flow (dotted lines), and 50th percentile, median flow (solid lines), obtained from the WAM monthly output files.

Figure 4.1-1. SNWW Low and Median Inflow Hydrographs



These inflows were used for all impact analyses. The low inflow runs were conducted for 5 months, June through October, with June and July used for model spin-up. The spin-up months allow the model to reach a dynamic equilibrium for salinity and are not used in the analysis. The model output for the 3-month period from August through October was used for the low-flow sensitivity analysis. The median-flow simulation covered 6 months, April through September, with only 1 month, March, used for spin-up. The shorter spin-up period for the median flow was because the higher flow resulted in lower water residence times in the system. The median-flow output was used for all impact analyses.

Additional boundary conditions include flows in and out of the GIWW on the east and west boundaries of the study area, direct precipitation inputs, and the Gulf boundary condition salinity. Details are provided in Brown and Stokes (2009).

4.1.2 Relative Sea Level Rise

While the future rate of RSLR at the Sabine-Neches Estuary is very uncertain, it must be considered in project planning. Current USACE guidance (ER 1105-2-100; April 2000) stipulates that NRC (1987) should be used to determine the potential impacts of sea level rise on plan formulation and engineering structures. RSLR consists of two components: global (eustatic) sea level rise and local subsidence. The uncertainty inherent in the rates of eustatic sea level rise is evident in the variability of the different modeled rates given for the NRC (1987) projections and the Intergovernmental Panel on Climate Change (IPCC, 2007). A similar degree of uncertainty exists with the rate of local subsidence.

A detailed review of both eustatic and local subsidence rates was performed by the ERDC (Brown and Stokes, 2009). This review found the eustatic rate estimates range from 1.8 mm/year to 6.45 mm/year for the next 50 years. This study employs an estimate for eustatic rise (4.5 mm/year) that is in the middle of the range projected by NRC (1987) and in the high middle range of that predicted by IPCC (2007). In coastal Louisiana, estimates of the local subsidence component of RSLR were found to range from 0.4 to 0.6 mm/year based on basal peat measurements (Törnqvist et al., 2006), 2 to 5 mm/year as averaged from 48 years of tide gage data (Morton et al., 2006), and to 10 to 15 mm/year as measured from settling rates of established benchmarks (Shinkle and Dokka, 2004). The ERDC's review concluded that the lower rates were the most technically valid. These lower rates represent long-term trends in the subsidence rate, and seem to be the closest approximation of consensus concerning the local subsidence rate that is currently available.

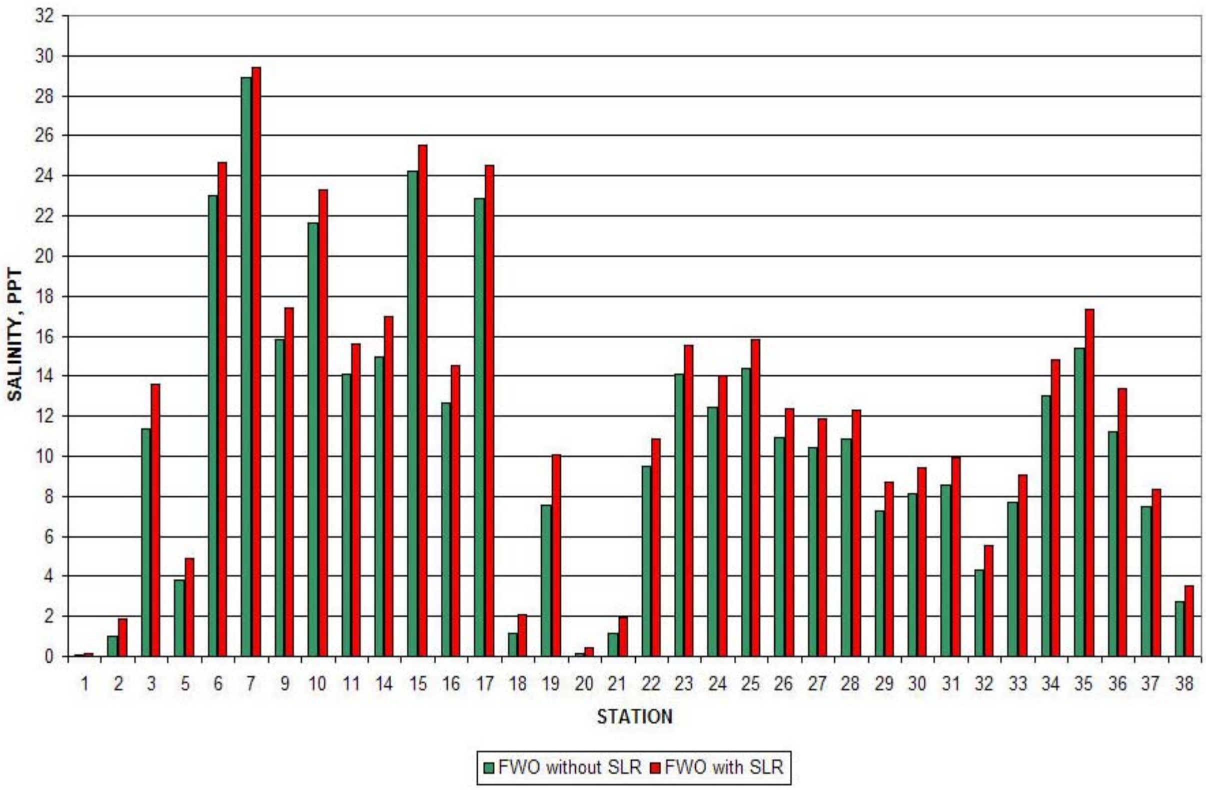
Adding these to the NRC II projections for eustatic sea level rise yields a value for the RSLR in the SNWW study area over 50 years of 4.9 to 5.1 mm/year. The average of these, 5.0 mm/year is used for modeling purposes.

Therefore, the "most likely" value of RSLR to be used for the SNWW deepening study's 50-year period of analysis is 250 mm (0.82 foot). Adjusting this to account for the period of analysis beginning in 2019 and ending in 2069 (the new period of analysis for the SNWW reformulation), the "most likely" amount of RSLR by the year 2069 is 335 mm (1.1 feet).

Figure 4.1-2 illustrates the effect of RSLR on predicted FWOP salinity in the system with the low (10th percentile) flows. The two simulations illustrate the salinity difference between the FWOP salinities without RSLR and the FWOP salinities with RSLR. Both simulations use the same inflows (WAMs 2060 inflows). At most stations, the RSLR is predicted to cause average salinity to increase about 1 ppt.

Incorporating RSLR in the HS model raises water elevation uniformly by 1.1 feet, which in turn allows greater salt transport through the system. At Bessie Heights, the salinity increase with the low-flow inputs is 2.0 to 2.5 ppt. At the median inflows, the salinity increase from RSLR is 1.0 to 1.5 ppt.

Figure 4.1-2. Mean Salinity Values, Low-Flow Conditions



4.1.3 Application of HS Model to Predict Project Effects

Having established the HS model's performance against field data and future conditions expected for freshwater inflows and RSLR, the next step is to use the model to predict changes in water elevations and salinity associated with project alternatives (the FWP condition). All simulations were performed using the low and median freshwater inflows and the 1.1 feet RSLR increase. Three types of project alternatives are considered: the 48-foot depth, other depth alternatives, and the effect of salinity mitigation measures.

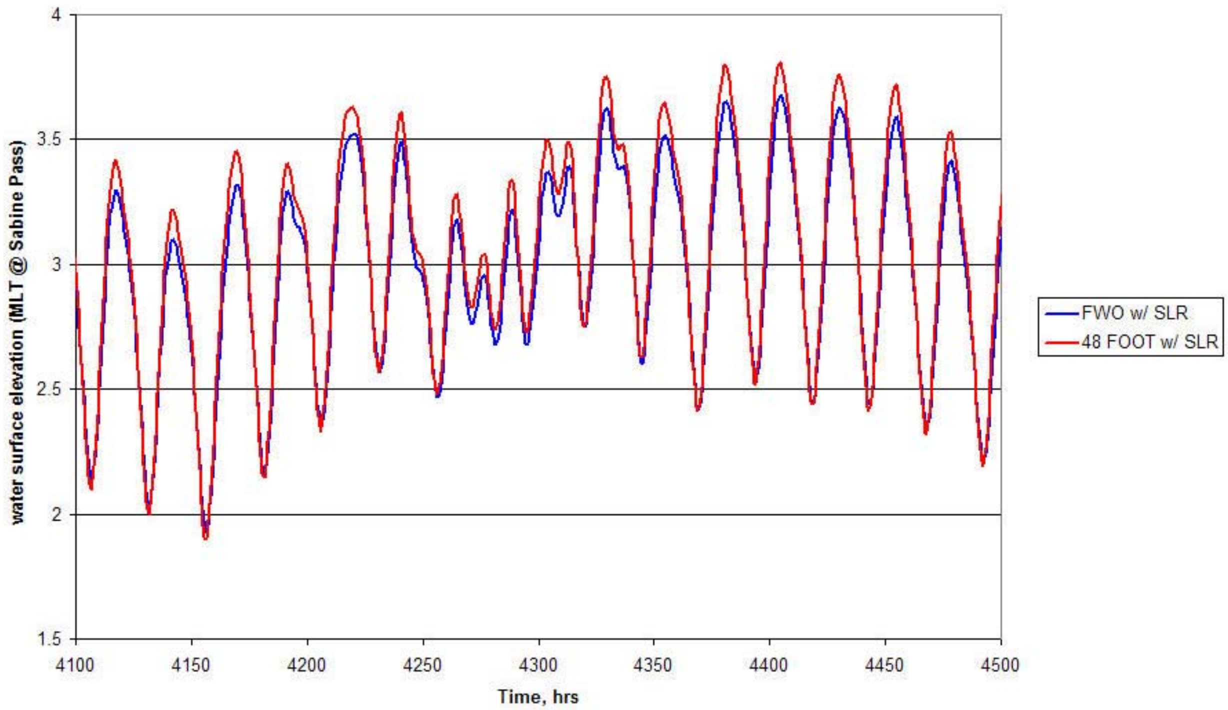
4.1.3.1 Water Surface Elevations – 48 Foot Channel

Water surface elevation over the study area was largely unaffected by the deeper navigation channel. An exception to the general result is the upper end of the Neches River near the saltwater barrier. Figure 4.1-3 provides a sample of the tides with and without the 48-foot channel at this location. The average high-water elevation appears to increase by 0.067 foot.

4.1.3.2 Salinity Changes – 48-Foot Channel

The effect of the 48-foot navigation channel is to increase salinity over most of the study area. The increase is greater for the median flows than for the low flows, reflecting a greater salinity gradient at high inflows, which allows a greater effect from the density current. Tables 4.1-1 and 4.1-2 provide a statistical analysis of salinity differences at 17 stations throughout the system for the low- and median-flow conditions. The tables provide the average differences between FWP and FWOP for surface, mid-depth, and bottom depths at each station.

Figure 4.1-3. Time Series of Tide at Neches River Salt Water Barrier – Low-Flow Case



The model salinity results are used for WVA modeling. The WVA requires input of "mean salinity" during the growing season and "mean high salinity" for impacts to fresh and intermediate habitats. The term "mean high salinity" is defined as the average of the highest 33 percent of consecutive salinity readings during a specified period of record. These two outputs of the HS model: mean and highest 33 percent, are the primary inputs to the WVA modeling.

4.1.3.3 Salinity Changes – Other Channel Depths

A model run with a 45-foot channel indicated that the salinity differences from the FWOP were similar to those with a 48-foot channel but lower in magnitude. To address salinity changes at other channel depths besides 48 and 45 foot, a quadratic equation was developed at each station based on model results at 0-, 5-, and 8-foot channel depth increase. This allowed the salinity change for each channel depth alternative to be predicted without having to model each deepening scenario independently.

Table 4.1-1
Statistical Analysis of Salinity Differences – Low Flow

	Average Differences												
Station Number	1	2	3	5	6	7	9	10	11	14	15	16	17
Surface Salinity	0.14	0.68	0.41	0.89	0.08	–0.31	1.03	–0.10	1.01	0.96	–0.05	1.01	0.02
Mid-depth Salinity	0.14	0.83	0.69	0.68	0.06	–0.25	1.03	–0.11	0.99	0.96	–0.04		0.01
Bottom Salinity	0.14	0.85	0.55	0.58	0.00	–0.21	1.03	–0.12	0.99	0.97	–0.05		0.00

	Standard Deviation of the Differences												
Station Number	1	2	3	5	6	7	9	10	11	14	15	16	17
Surface Salinity	0.15	0.20	0.36	0.49	0.45	0.32	0.17	0.55	0.18	0.13	0.40	0.20	0.23
Mid-depth Salinity	0.15	0.18	0.20	0.32	0.47	0.27	0.17	0.55	0.15	0.13	0.40		0.23
Bottom Salinity	0.15	0.23	0.25	0.35	0.47	0.26	0.17	0.55	0.15	0.14	0.41		0.23

Note: Statistics calculated after the spin-up period (hr 5088-7296)

Table 4.1-2
Statistical Analysis of Salinity Differences – Median Flow

	Average Differences												
Station Number	1	2	3	5	6	7	9	10	11	14	15	16	1.62
Surface Salinity	0.00	0.13	0.79	0.23	1.60	0.11	1.37	1.18	1.09	1.61	1.41	1.38	1.60
Mid-depth Salinity	0.00	0.16	1.18	0.22	1.78	0.25	1.37	1.16	1.11	1.62	1.42		1.58
Bottom Salinity	0.00	0.26	1.18	0.21	1.70	0.29	1.38	1.12	1.11	1.62	1.41		

	Standard Deviation of the Differences												
Station Number	1	2	3	5	6	7	9	10	11	14	15	16	17
Surface Salinity	0.01	0.22	0.64	0.44	1.20	1.01	0.73	0.90	0.73	0.59	0.88	0.61	0.83
Mid-depth Salinity	0.01	0.28	0.69	0.38	1.24	0.98	0.73	0.92	0.73	0.59	0.92		0.83
Bottom Salinity	0.01	0.43	0.63	0.37	1.26	0.95	0.73	0.97	0.73	0.60	0.97		0.83

	Highest 10 Percent of Differences												
Station Number	1	2	3	5	6	7	9	10	11	14	15	16	17
Surface Salinity	0.01	0.55	1.63	0.91	3.04	1.53	2.26	2.14	2.01	2.42	2.47	2.24	2.79
Mid-depth Salinity	0.01	0.68	1.92	0.89	3.33	1.63	2.26	2.15	2.00	2.44	2.51		2.78
Bottom Salinity	0.01	1.03	1.87	0.84	3.26	1.65	2.26	2.14	2.00	2.47	2.51		2.78

Note: Statistics calculated after the spin-up period (hr 2136-6552)

4.1.3.4 Salinity Changes – Salinity Mitigation Measures

Three types of salinity mitigation measures were considered: large scale, small scale, and local. The large-scale measures are those such as Rose City, Bessie Heights East and West, and Old River Cove. These large-scale measures have the potential to influence the entire system and were modeled with the TABS-MDS model. The small-scale features were evaluated with a desktop model, and the local measures such as shoreline restoration or plugging of a logging canal were not modeled. The salinity results were used to develop WVA benefits for the wide array of mitigation measures that were evaluated during the preliminary screening of mitigation measures. The model runs for the large-scale measures were primarily concerned with reclamation of wetlands along the Neches River. Salinity reductions predicted by the modeling would only be effective if all of the proposed measures were adopted. Least-cost analyses resulted in the exclusion of Bessie Heights West, a large feature that contained about one-third of the proposed reclamation area. An FWP reduction in salinity is not forecast in conjunction with reclamation of the remaining components of the Neches River BU Feature because salinity effects of this revised BU plan have not been modeled, and the removal of Bessie Heights West would be expected to significantly reduce salinity benefits.

4.1.4 Application of the WVA Model

4.1.4.1 Comparison of the FWOP and FWP Conditions

The WVA methodology provides a comprehensive, quantitative estimate of FWP changes in the quality and quantity of emergent marsh, cypress-tupelo swamp, and bottomland hardwood forests.

Each WVA model consists of variables considered important to each habitat type and suitability indices (SI) for each variable. All of the variable SIs for a specific community (i.e., fresh/intermediate, brackish, or saline marsh; swamp; bottomland hardwood) are combined in a mathematical formula to calculate the Habitat Suitability Index (HSI), which represents the composite habitat quality of the wetland being evaluated. Within each HSI formula, important variables may be weighted relative to other variables in the formula. The HSI formulae employed for the SNWW ecological modeling are based on those developed by the CWPPRA Environmental Work Group (USFWS, 2002a, 2002b, 2002c).

The WVA methodology quantifies changes in specific wetland structural and functional characteristics determined to be significant indicators of habitat health and quality. It combines the effects of changes in wetland productivity and structure to calculate impacts measured as AAHU values. Future without project and FWP conditions for the period of analysis were projected using salinities from the HS model as input into the WVA model. The FWOP condition predicts changes expected to occur under the No-Action Alternative described in Section 3. The FWP condition addresses the changes expected to result from project construction, including impacts from the placement of dredged material, benefits of the BU features, and effects of the compensatory mitigation plan.

HSIs are established for the FWOP and FWP conditions for selected target years (TY) throughout the life of the project. Habitat units are calculated by multiplying these HSIs by the affected acreage at each target year. The habitat units for the FWOP and FWP conditions totaled over the project life are divided by the total years of the project to determine AAHUs. Small changes in some variables like salinity, when applied to thousands of acres in the large hydrologic units in this study area, produce the changes in AAHUs shown tables 4.1-3 and 4.1-4 for Texas and Louisiana, respectively. The impacts or benefits of the project are then quantified by comparing AAHUs between FWP and FWOP conditions. This procedure fulfills the USACE requirement that compensation be evaluated using a unit of comparison that measures quality and quantity of habitat values over time.

The same procedure used to estimate FWP land loss was used to quantify the compensation associated with mitigation measures, which is described in detail in Chapter 5. Screened mitigation measures affected salinities in some areas, blocked shoreline retreat, and restored emergent marsh elevations in others. These changes were reflected in land loss tables specific to each mitigation measure as follows: (1) revised FWP land loss rates were calculated by substituting salinity values predicted by the HS model (Brown and Stokes, 2009) in the land loss rate formula for hydro-units on the Neches River; (2) acreages were adjusted in the land loss tables to account for the effect of mitigation measures, such as breakwaters or shoreline nourishment, which stopped or slowed existing shoreline retreat; and (3) acreages were adjusted in the land loss tables to add emergent marsh acres restored by the placement of dredged material or in-situ marsh terracing. Credit for marsh acreage was generally delayed by 1 year to allow time for planted and volunteer marsh vegetation to become established. This is based upon recent experience with CWPPRA and other marsh restoration projects in the lower Sabine and Neches watersheds where marsh plantings and natural vegetation rebounded quickly and robustly to create a stable marsh landscape.

Procedures to estimate the effects of mitigation measures deviate from the FWP land loss method in the specific instances where mitigation measures add mineral soils to degraded areas of former marsh. In these cases, the ICT projected that the loss rate for the mitigation areas would be lower because the addition of denser, mineral soils and the increase in marsh elevation would create a more stable landform. Accordingly, land loss rates due to the project were reduced by 50 percent in the land loss change spreadsheets for these areas. Other mitigation measures that did not involve the creation of a higher, more-stable landform were modeled using a land loss rate equivalent to the FWP rate.

4.1.4.2 Emergent Marsh Community Models

The EMCMs were used to evaluate saline, brackish, intermediate, and fresh marsh habitats in the study area. Variables included in the models were selected based upon their importance to fish and wildlife in coastal marsh ecosystems. A large number of species-specific HSI models for a variety of fish and shellfish, freshwater fish, birds, reptiles and amphibians, and mammals were reviewed and considered in the development of model assumptions. Six variables represent wetland habitat quality in the model:

Table 4.1-3
SNWW WVA Impacts Summary – Before DMMP Benefits
and Mitigation (Louisiana Impacts Sorted by AAHUs)

HU #	Hydrologic Unit	Habitat Type	FWOP Net Change Acres	FWP Net Change Total Acres	FWP Net Change % Acres	FWOP Net Change AAHUs	FWP Net Change AAHUs	FWOP Salinity (ppt)	FWP Salinity (ppt)	FWP Net Salinity Change (ppt)
LA 3	Black Bayou	Intermediate Marsh	–1,713	–130	–0.3	14,734	–509	4.00	5.10	1.1
LA 2	Willow Bayou	Intermediate (Brackish lumped)	–2,116	–102	0.3	11,249	–328	6.30	7.20	0.9
LA 4	West Johnson’s Bayou	Intermediate Marsh	–1,703	–142	–0.8	5,729	–269	6.30	7.50	1.2
LA 5	Sabine Lake Ridges	Intermediate Marsh	–1,103	–93	–0.7	4,868	–218	6.30	7.50	1.2
LA 9	East Johnson’s Bayou	Intermediate Marsh	–895	–46	–0.2	13,820	–190	4.20	5.20	1.0
LA 1	Perry Ridge	Fresh Marsh	–921	–50	–0.2	8,947	–65	0.90	1.24	0.3
LA 1	Perry Ridge	Intermediate Marsh	–191	–12	–0.1	1,873	–53	0.90	1.24	0.3
LA 5	Sabine Lake Ridges	Saline Marsh	–398	–10	–0.5	2,184	–35	17.00	18.40	1.4
LA 8	Southwest Gum Cove	Fresh Marsh	–152	–8	–0.3	2,170	–2	1.20	2.10	0.9
LA 5	Sabine Lake Ridges	Brackish Marsh	–2,567	–43	–0.1	9,113	–14	8.00	8.60	0.6
LA 7	Southeast Sabine	Fresh Marsh	–40	0	0.0	1,231	–11	1.80	2.30	0.5
LA 6	Johnson’s Bayou Ridge	Brackish Marsh	–707	–22	–0.3	1,285	–6	6.00	6.70	0.7
LA 8	Southwest Gum Cove	Intermediate (Brackish lumped)	–233	–15	–0.2	3,253	–4	2.40	3.30	0.9
LA 6	Johnson’s Bayou Ridge	Saline Marsh	–93	–5	–1.0	195	–2	12.00	13.80	1.8
LA 3	Black Bayou	Brackish Marsh	–803	–4	0.0	1,643	–1	3.00	3.80	0.8
LA 4	West Johnson’s Bayou	Brackish Marsh	–1,189	–6	–0.2	768	–1	6.00	6.70	0.7
LA 2	Willow Bayou	Brackish Marsh	–695	–2		498	–1			1.4
LA/TX 1	Sabine Island	Cypress/Tupelo Swamp	0	0	0.0	4,499	0	0.69	1.10	0.4
LA/TX 2	Blue Elbow	Cypress/Tupelo Swamp (BH lumped)	0	0	0.0	300	0	1.00	1.60	0.6
LA 7	Southeast Sabine	Intermediate (Brackish lumped)	–96	–1	0.0	3,204	0	1.80	2.00	0.2
LA 1	Perry Ridge	Bottomland Hardwood	0	0	0.0	2,080	0	0.90	1.24	0.3
LA/TX 1	Sabine Island	Bottomland Hardwood	0	0	0.0	999	0	0.69	1.10	0.4
Total			–15,615	–691		94,642	–1,709			

Table 4.1-4
SNWW WVA Impacts Summary – Before DMMP Benefits and Mitigation (Texas Impacts Sorted by AAHUs)

HU #	Hydrologic Unit	Habitat Type	FWOP Net Change Acres	FWP Net Change Total Acres	FWP Net Change % Acres	FWOP Net Change AAHUs	FWP Net Change AAHUs	FWOP Salinity (ppt)	FWP Salinity (ppt)	FWP Net Salinity Change (ppt)
TX 7	GIWW North	Fresh (Intermediate lumped)	–539	–63	–0.4	2,602	–140	0.70	1.20	1.6
TX 6	Old River Cove	Brackish Marsh	–1,518	–46	–0.3	3,061	–116	10.00	11.00	1.8
TX 3	Rose City PA24A	Fresh Marsh	–3	–86	–63.3	53	–32			0.3
TX 8	Texas Point	Intermediate (Fresh lumped)	–245	–6	–1.3	940	–19	5.50	8.00	0.8
TX 12	Blue Elbow South	Cypress/Tupelo Swamp	0	0	0.0	418	–18	1.67	2.60	0.6
TX 10	Cow Bayou	Fresh Marsh	–75	–6	–0.1	824	–18	2.00	2.20	1.0
TX 11	Adams Bayou	Fresh Marsh	–28	–3	–0.7	305	–15	2.10	4.10	1.5
TX 5	Bessie Heights	Intermediate (Brackish lumped)	31	–1	0.0	1,273	–14	4.20	4.70	0.3
TX 10	Cow Bayou	Intermediate Marsh	–59	–3	0.0	741	–12	2.00	2.20	1.0
TX 7	GIWW North	Brackish Marsh	–62	–2	–0.1	380	–8	9.00	9.60	1.6
TX 8	Texas Point	Brackish Marsh	–252	–5	–0.4	1,464	–7	8.50	11.00	0.8
TX 8	Texas Point	Saline Marsh	–2,446	–17	–0.9	2,480	–5	12.50	15.00	0.8
TX 11	Adams Bayou	Cypress/Tupelo Swamp	0	0	0.0	44	–4	2.10	4.10	0.8
TX 13	Groves	Intermediate Marsh	–68	–3	–0.7	220	–3			1.0
TX 3	Rose City	Fresh Marsh	–93	–3	–0.1	1,365	–1	0.25	0.55	0.3
TX 2	Neches-Lake Bayou	Cypress/Tupelo Swamp	0	0	0.0	1,977	0	2.00	2.90	0.0
TX 1	North Neches River	Cypress/Tupelo Swamp	0	0	0.0	2,399	0	0.90	1.70	0.0
LA/TX 2	Blue Elbow	Cypress/Tupelo Swamp (BH lumped)	0	0	0.0	1,261	0			0.3
TX 2	Neches-Lake Bayou	Fresh Marsh	–24	0	–0.1	808	0	2.00	2.90	0.1
LA/TX 1	Sabine Island	Cypress/Tupelo Swamp	0	0	0.0	896	0			0.0
TX 5	Bessie Heights	Fresh Marsh	–40	–2	–0.1	1,313	0	1.00	1.50	0.5
TX 1	North Neches River	Fresh Marsh	–8	0	0.0	249	0	0.90	1.70	0.0
TX 10	Cow Bayou	Cypress/Tupelo Swamp	0	0	0.0	55	0	2.00	2.20	1.0
TX 4	West of Rose City	Fresh Marsh	–24	–1	–0.1	238	0	0.10	0.40	0.4
TX 5	Bessie Heights	Bottomland Hardwood	0	0	0.0	225	0	1.00	1.50	0.5
TX 3	Rose City	Cypress/Tupelo Swamp	0	0	0.0	217	0	0.25	0.55	0.3
TX 1	North Neches River	Bottomland Hardwood	0	0	0.0	277	0	0.90	1.70	0.0
LA/TX 1	Sabine Island	Bottomland Hardwood	0	0	0.0	503	0			0.0
TX 3	Rose City	Bottomland Hardwood	0	0	0.0	698	0	0.25	0.55	0.3
TX 6	Old River Cove	Bottomland Hardwood	0	0	0.0	149	0	1.00	1.50	0.5
TX 10	Cow Bayou	Bottomland Hardwood	0	0	0.0	286	0	2.00	2.20	1.0
TX 11	Adams Bayou	Bottomland Hardwood	0	0	0.0	402	0	2.10	4.10	0.8
TX 2	Neches-Lake Bayou	Bottomland Hardwood	0	0	0.0	1,164	0	2.00	2.90	0.0
	Totals		–5,453	–247		28,124	–412			

V_1 percent of the wetland covered by emergent vegetation

V_2 percent of the open water covered by SAV

V_3 marsh edge and interspersion

V_4 percent of the open-water area less than or equal to 1.5 feet deep

V_5 salinity

V_6 aquatic organism access

The reader is cautioned that straightforward comparisons of impacts associated with changes in salinity or other variables are not easily made between hydro-units. The varying AAHUs and acreage results are due to differences in project impacts, underlying conditions (i.e., existing land loss rate, marsh interspersion, SAV), and the size of the hydro-unit. Salinity is not the only determinant; changes in other variables can also have significant effects. Additional information about the weighting of variables is provided below. However, refer to Appendix C of the FEIS for detailed narratives of the FWOP and FWP conditions in each hydro-unit.

The primary focus of the SNWW application of the EMCM is the preservation of vegetated wetlands, but it is also recognized that some marsh restoration or protection strategies could have an adverse effect on aquatic organisms. Therefore, variables V_1 (percent emergent vegetation), V_2 (percent SAV), and V_6 (aquatic organism access) are grouped together and weighted more than the remaining variables. For all marsh models, V_1 receives the greatest weighting; however, the relative weights of V_1, V_2, and V_6 vary by marsh model to reflect different levels of importance between the marsh types.

The EMCM employs a split model format to account for the value of both marsh and open-water habitats. Two HSI formulas are calculated for each marsh type – one for emergent marsh habitat and one for open-water habitat. The HSI formula for emergent marsh contains the variables important for evaluating its habitat quality (V_1-percent coverage of emergent vegetation, V_3-marsh edge and interspersion, V_5-salinity, and V_6-aquatic organism access). The HSI formula for open-water habitat contains only the variables important to that habitat component (V_2-percent open water with SAV, V_3-marsh edge and interspersion, V_4-percent open water <1.5 feet deep, V_5-salinity, and V_6-aquatic organism access).

4.1.4.3 Swamp Community Model

The SCM uses variables that evaluate the ability of swamps to provide resting, foraging, and nesting habitat for a wide variety of wildlife species. In general, the swamp model can be applied if woody canopy cover is at least 33 percent of the surface area, and at least 60 percent of the canopy consists of any combination of bald cypress, tupelo gum, red maple, buttonbush, and/or planertree (*Planera aquatica*). The following four variables represent swamp habitat quality in the model:

V_1 stand structure

V_2 stand maturity

V_3 water regime

V_4 mean high salinity during the growing season

All of the SIs are combined in a mathematical formula, the HSI, which represents the composite habitat quality. Variables V_1 and V_3 (stand structure and water regime) are considered the most important variables in characterizing swamp habitat quality and therefore are weighted more than other variables. Variables V_1 and V_2 were adjusted for the dampening effect of salinity on tree growth, using output from the HS model. Variable V_4 (salinity) is weighted lower than the other variables.

4.1.4.4 Bottomland Hardwood Model

The BHM applies to forested wetlands that support a canopy of woody vegetation of which more than 40 percent of tree species consist of oaks, hickories, American elm, cedar elm, green ash, sweetgum, sugarberry, boxelder (*Acer negundo*), common persimmon (*Diospyros virginiana*), honeylocust (*Gleditsia triacanthos*), red mulberry (*Morus rubra*), eastern cottonwood (*Populus deltoides*), black willow (*Salix nigra*), and American sycamore (*Platanus occidentalis*). Variable selection for the model was based upon a review of various USFWS HSI models for bottomland hardwood wildlife. The following variables represent bottomland hardwood habitat quality in the model:

V_1 tree species composition

V_2 stand maturity

V_3 midstory/understory

V_4 hydrology

V_5 size of contiguous forested area

V_6 surrounding land uses

V_7 disturbance

The model incorporates site-specific habitat quality features (tree species composition, forest stand structure, stand maturity, and hydrology) and landscape parameters (forest size, surrounding land use, and disturbance). Because the primary application of this model is to quantify the loss of ecological values due to changes in the site-specific conditions, variables that are likely to be affected by these changes (V_1, V_2, V_3, and V_4) are considered more important than the landscape variables. Of the site-specific variables, V_1 (tree species composition) and V_2 (stand maturity) are considered equal and of greater importance than the other variables. Variable V_3 (understory/midstory) and V_4 (hydrology) are weighted less than V_1 and V_2. The "landscape" variables (V_5, V_6, and V_7) are not weighted. Variables V_1, V_2, and V_3 were adjusted for the dampening effect of salinity on tree growth, using output from the HS model.

4.1.5 Storm Surge Sensitivity Modeling

The potential for proposed project features to increase storm surge impacts in the study area was analyzed with a storm surge sensitivity analysis (Wamsley et al., 2010). The ADCIRC model was run to estimate water levels for two worst-case hypothetical storms, both with and without proposed SNWW CIP project features in place. Project features evaluated by the modeling are the deeper navigation channel, proposed PAs with maximum levee heights, and two expanded PAs. The two simulated storms exhibited minimum central pressures of 900 millibars, offshore pressure radii between 14.9 and 18.4 nautical miles, and forward speeds of 11 knots. Each produced water levels near or higher than the estimated 500-year level, and both would be considered extreme events. One storm tracked in the northwesterly direction, producing maximum surges of 18 feet near the coast at Sabine Pass and surges of 13–14 feet in Sabine Lake near Port Arthur, Texas. The second storm tracked in a north-northeasterly direction, producing maximum surges of over 20 feet near Sabine Pass and surges of 15 to 17 feet in Sabine Lake near Port Arthur.

The sensitivity analysis concluded that the greatest changes would occur north of Port Arthur along the Neches River. These changes are primarily due to the proposed increase in depth of the navigation channel. All changes are local, and there are no project-induced increases in surges away from the immediate vicinity of the navigation channel. Water levels in the marshes and open-water areas immediately north of the river would increase on the order of 4 to 8 inches or less. The modeling indicates some interior flooding would occur within the City of Port Arthur with both storms, both with and without the project. Changes in peak surge within the city for these two events, with the project in place, are caused by a slight increase in surge elevation and/or duration causing additional overtopping of the surrounding levee or internal topographic features. Peak surges for 100-year events are estimated to be approximately 9 feet in the Port Arthur area. Although simulations of less-intense events were not made as part of this study, in light of the 14- to 24-foot levees surrounding Port Arthur, significant interior flooding is not expected for the base condition. Any changes in peak surge on the order of inches should not cause any significant change in interior flooding for the with-project condition.

The Preferred Alternative for the SNWW CIP also includes ODMDS and marsh restoration measures. All of the existing and proposed ODMDSs are located several miles from the Gulf shoreline in water too deep to affect wave setup on the shoreline. The influences of marsh restoration on hurricane surge have been documented by Wamsley et al. (2009a, 2009b). Surges tend to slightly increase over and just seaward of the marsh as the surge propagation is slowed, which may result in reductions in peak water levels landward of marsh features. The impact of the proposed SNWW CIP marsh restoration features is relatively small and expected to modify peak surge levels locally by a minimal amount (Wamsley et al., 2010). No significant reductions or increases in surge level would be expected from either the marsh restoration or ODMDS.

4.2 UNCERTAINTIES ASSOCIATED WITH ECOLOGICAL MODELING FOR THE SNWW CIP

An analysis of risk and uncertainty associated with the WVA model application to the SNWW CIP has been performed in consideration of recommendations contained in the Actions for Change directive (USACE, 2006d). This analysis will facilitate risk-informed decision-making regarding the levels of ecological impacts and resulting recommended compensatory mitigation that were established using the models. The primary risks associated with ecological modeling for the SNWW CIP relate to the accuracy of the impact assessment and the cost of mitigation. Risks to human health or safety associated with ecological impacts are small. Incremental marsh loss attributable to the Preferred Alternative (approximately 691 acres or about 2/5th of 1 percent of emergent marsh in the study area) would not affect the overall effectiveness of the coastal wetlands in buffering inland areas from storm surge effects.

An evaluation of the risks and uncertainties involved in application of the ecological model, on which the amount of proposed compensatory mitigation is based, is necessary to evaluate the adequacy of the recommended amount of ecological mitigation, and to support the recommended Federal investment. The reader is referred to Appendix C of this FEIS for the complete sensitivity analysis, including detailed methodology and analysis. A brief summary of the results of the analysis is presented below.

There are two types of uncertainty that have been identified for the predictive ecological modeling conducted in this study—uncertainty associated with model quality and performance, and uncertainty associated with model predictions. In regard to the first type of uncertainty, extensive technical review of the WVA models has been conducted to ensure that they are technically sound and defensible (LBG and TEA, 2008). The assessment determined that the concept and application of the models are sound for planning efforts. Theoretical approaches of the WVA models use scientifically established structural surrogates to evaluate wetland quality. The models' variables provide a reasonable description of the emergent marsh, swamp, and bottomland hardwood habitats, and are capable of evaluating project effects to habitat-based, functional processes that may be affected by the project. Based upon the results of this assessment, the Deep Draft Navigation Planning Center of Expertise, in consultation with the National Ecosystem Planning Center of Expertise, concurred with the findings of this assessment and approved the use of the WVA EMCM, BHM, and SCM for the SNWW feasibility study (Memorandum for Commander, HQ USACE [CECW-PC] and Commander, Southwest Division [CESWD-PDS] from the Director of Deep Draft Navigation Planning Center of Expertise [CESAD-PDS-P], dated June 30, 2009). This satisfies the requirements of EC 1105-2-407, as the WVA models were developed by a Federal agency other than the USACE, and are therefore subject to approval for use rather than certification.

Uncertainty associated with predictions of the WVA models (i.e., how different predictable outcomes could affect ecological impacts and costs) was evaluated by varying input values for the most significant variables. The WVA models do not include a direct way to measure risk, i.e., the model does not calculate a probability distribution that provides a statistically significant confidence level for the model projections. Since salinity is the driving force influencing WVA model predictions, salinity-related variables were targeted in one sensitivity analysis. The other analysis focused on an assumption underlying the valuation of the percent of emergent marsh cover. A range of possible outcomes associated with variable V_1 (percent of emergent marsh) in the EMCM, and variables V_4 and V_5 (salinity) in the SCM and EMCM, respectively, were evaluated to determine how uncertainties related to variable assumptions and values could affect impact predictions and compensatory mitigation decisions. Since the analysis was conducted to evaluate uncertainties with the recommended level of compensatory mitigation, the analysis was performed for the Louisiana hydro-units in which unavoidable impacts would occur.

4.2.1 Salinity Sensitivity

Because of uncertainties associated with HS model predictions of salinity impacts, a sensitivity analysis was performed to evaluate the full range of potential project effects. Salinity changes predicted with implementation of the Preferred Alternative were provided by the HS model. High- and low-salinity values bracketing the 95 percent confidence level were entered into WVA model for all habitats in Louisiana hydro-units. Ranges of AAHU impacts were then produced based on the 95 percent salinity range.

For cypress-tupelo swamps, the sensitivity analysis yielded a range of potential loss from 0 to 9 AAHUs, with no impact predicted to be most likely. The uppermost reaches of the Sabine River would remain essentially fresh; however, the Blue Elbow swamp near the GIWW could experience suboptimal salinities at the high end of the salinity range. Even at the maximum salinity, levels would not be suboptimal to the extent that sustainability of the swamp forest would be threatened. No impacts would be expected in the bottomland hardwood habitats at the maximum range of salinity predicted by the sensitivity analysis.

The largest range of potential impacts could occur within the intermediate marsh communities located east of Sabine Lake. AAHU losses for the intermediate marshes could range from 312 to 2,407 AAHUs, as compared to the FWP’s most likely loss of 1,571 AAHUs. The highest potential salinities are suboptimal for most of the intermediate marshes east of Sabine Lake, and some exceed the maximum tolerance range. At the highest potential salinities, intermediate marshes in Willow Bayou, West Johnson’s Bayou, and Sabine Lake Ridges would likely convert to brackish marsh about 20 years after project construction.

Impacts at the highest potential salinities would not threaten the sustainability of any of the other marsh communities over the period of analysis. Salinities remain within or close to the optimal range. For fresh marsh communities, AAHU losses could range from 8 to 477, as compared to the most likely loss of 78 AAHUs. For saline and brackish marshes combined, AAHU losses could range from 20 to 253, as compared to the FWP’s most likely loss of 60 AAHUs.

The salinity sensitivity analysis of the WVA models demonstrated that there is a wide range of potential outcomes in AAHU losses attributable to uncertainties in salinity predictions. These outcomes range from a loss of 340 to 3,146 AAHUs within the 95 percent confidence range of salinity, the primary driver in the EMCM and SCM. After adjustments for the Gulf Shore BU Feature benefits (210 AAHUs) and the BU offset of impacts to Federal lands (340 AAHUs), losses could range from zero to 2,596 AAHUs. Based on the cost per AAHU of the recommended mitigation plan ($77.5 million; 1,181 AAHUs), the cost of compensatory mitigation could range from $0 to about $170 million. The total predicted FWP loss of 1,499 AAHUs in Louisiana is based upon forecasts of the most likely salinity levels, and takes into account the potential FWOP effects of RSLR and changes in future freshwater inflows.

4.2.2 Percent Emergent Marsh Sensitivity Analysis

Ninety-nine percent of Louisiana impacts predicted by the ecological model were made using the EMCM. The most highly weighted variable in this model is V_1 (percent emergent marsh). This parameter is considered most significant because persistent emergent vegetation provides foraging, resting, and breeding habitat for a variety of coastal fish and wildlife species. Detritus from coastal marshes also provides a source of mineral and organic nourishment for organisms at the base of the food chain. Without the structure provided by the emergent marsh, the majority of the ecological benefits provided by this system disappears. Changes in the value of this parameter were predicted by relating changes in salinity to changes in marsh loss using a process that is described in Section 4.10. This sensitivity analysis explores the effects of an assumption that underlies the valuation of emergent marsh in this variable. The SNWW application of this model uses the same assumptions adopted by the EnvWG in its application of the model to CWPPRA restoration projects (USFWS, 2002b). In this model, optimal vegetative coverage is assumed to be 100 percent (SI = 1.0) for all marsh types. This assumption diverges from the general biological understanding that optimal cover falls in the 60 to 80 percent range, but it was adopted by the EnvWG to reflect CWPPRA's objective of long-term marsh creation and restoration. Questions have arisen as to whether maximizing the value of marsh coverage is appropriate for the SNWW application in which the primary purpose is the identification of project impacts and compensatory mitigation.

Selection of 100 percent marsh cover as the optimal habitat condition (V_1-Original) for the SNWW application was based upon several factors. Maximizing the value of emergent marsh over associated shallow-water habitat is based upon the important ecological concept of long-term sustainability. With the SNWW project, marshes would continue to degrade over the 65-year period of analysis due to the effects of RSLR. Without the associated marshes, the small open-water areas would lose their value as nursery habitat, becoming open-bay or open-Gulf habitat. Restoration or mitigation projects generally need to maximize the creation of emergent marsh, so as to ensure the sustainability of the land itself.

To evaluate the effect of this assumption on the SNWW application, the EMCM was rerun for all of the Louisiana marsh communities using a revised formula for the variable in which optimal vegetative coverage (SI = 1.0) is assumed for a marsh coverage of 60 to 80 percent (V_1-Revised). Overall, impacts using V_1-Revised dropped by 3 percent. As would be expected, the smallest percentage changes occurred in marshes where the percent emergent marsh remained between 60 and 80 percent for both the FWOP and FWP conditions. If the V_1-Revised formula were used to calculate the mitigation target for the recommended mitigation plan, the net loss would be 244 AAHUs. If V_1-Revised were used to compute compensatory mitigation as it is currently designed, mitigation costs would increase by at least 42 percent to meet the V_1-Revised mitigation target.

If the same mitigation measures were redesigned so that marsh fill would never exceed 80 percent, the amount of restored acres would drop from 2,696 to 2,215 acres. However, compensation as measured with the V_1-Revised formula would increase and the net loss would be 167 AAHUs. Based upon the cost of the recommended mitigation plan, it is estimated that the total mitigation cost would be about 3 percent greater than the recommended mitigation plan. More significantly, the modified plan would restore about

18 percent fewer acres and do less to ensure the long-term sustainability of the marsh than the recommended mitigation plan.

4.2.3 Recommendations Resulting from WVA Model Sensitivity Analysis

The recommended compensatory mitigation plan is based upon the most likely range of salinity change as established by the HS model, scientifically based projections of changes in habitat resulting from the predicted salinity change, and the professional judgment and knowledge of the area by the large team of natural resource and engineering professionals who applied the WVA model to the SNWW CIP. The ICT HW contained professionals with expertise in wetland impact evaluation, marsh restoration, wetland forest management, aquatic habitat evaluation, freshwater and marine fisheries, terrestrial and avian wildlife biology, as well as natural resource management personnel from all of the protected lands in the study area.

In addition, the recommended mitigation plan maximizes the value of emergent marsh when measuring impacts and determining compensatory mitigation for project-related losses to this nationally significant, endangered resource. Without the structure provided by the emergent marsh, the majority of the ecological benefits provided by these systems disappear. For these reasons, no changes to the recommended mitigation plan are proposed as a result of this sensitivity analysis. It is recommended that Best Buy Plan #6 mitigation plan (described in Chapter 5) be selected as it incorporates the level of compensation needed to address the most likely impacts of the SNWW CIP.

4.3 PHYSIOGRAPHY AND GEOLOGY

4.3.1 No-Action Alternative

The No-Action Alternative would not impact physiography or geology within the study area. Alterations to bathymetry from maintenance dredging of existing ship channels, in addition to topographic changes from the placement of dredged materials at PAs, would continue under the No-Action scenario.

4.3.2 Preferred Alternative

The total estimated amount of dredged material generated from the proposed project would be approximately 98 mcy of new work material and approximately 650 mcy of maintenance material over 50 years after the project is constructed. This material would be placed in BU features, PAs, and ODMDSs, as described in Section 2.5.

Impacts on local geology during dredging associated with the Preferred Alternative would include redistribution of existing sediment, local increases in turbidity, and potential changes in local scouring and shoaling rates. Net impacts on local geology would be minimal from these operations. Additionally, no impacts or modifications to geologic hazards such as faulting and subsidence are expected.

Two PAs would be created. The area where PA 24A would be created is currently a wetland habitat with a central upland ridge, which is set back from the shoreline of a Neches River oxbow and does not block overland flow to bottomland hardwoods along the shore. A critical section of marshhay cordgrass wetland was excluded from the proposed PA, and the boundaries were drawn to exclude bottomland hardwoods that line the Neches River oxbow west of the PA. The area where PA 18A would be created is already an upland area so there should be no topographic impact. Further information pertaining to specific PA descriptions and quantities of new work and maintenance material involved are presented in Section 2.4.

Three miles of shoreline located at Texas and Louisiana Points would be affected by the proposed Gulf Shore BU Feature (see Figure 2.5-2). Over the 50-year period of analysis, 16 placement episodes are expected, occurring in 3-year cycles, alternating between Texas and Louisiana. The Gulf Shore BU Feature would provide a regular source of predominantly fine-grained sediment that should contribute to mudflat accretion and periodically move onshore to become shore-attached through a process described by PIE (2003). On the western Louisiana and east Texas coasts, sediments accumulate as mudflats and underwater mudshoals (or “fluid mud”) in the nearshore region. Nearshore, fluid mud can be trapped against the shoreline by prevailing south and southwesterly winds, and storms carry the trapped muddy ooze onto the chenier shoreline. The presence of additional fine-grained sediments in the littoral system that would be provided by the BU feature should reduce the current erosion rate, and minimize the small increase in shore erosion predicted with the project (Gravens and King, 2003). In systems that have an abundant supply of fine-grained sediments, the nearshore seabed can be blanketed with fluid mud. The presence of additional muddy sediment in the nearshore environment may attenuate waves and lessen wave-induced erosion (Hsiao and Shemdin, 1980; Tubman and Suhayda, 1976; Wells and Kemp, 1986). Although the BU sediments would be largely fine grained, approximately 18 percent of maintenance material is expected to be sand. Sands that are deposited on shore would nourish and stabilize eroding marshes; sand deposited in the nearshore zone should stay in the nearshore environment, moving back and forth across the shoreface (Wamsley, 2008). More details on the expected behavior of the material can be found in subsection 2.5.3.2.

Three degraded marsh areas along the Neches River would be combined into the Neches River BU Feature. This large BU feature would use new work material and future maintenance material to benefit a total of 4,958 acres of degraded marsh on the lower Neches River by restoring 2,853 acres of emergent marsh; improving 871 acres of shallow water by creating shallower ponds and interconnecting channels; and nourishing 1,234 acres of existing fringing marsh by winnowing fine-grained material from unconfined flows of dredged material effluent. It would fulfill 53 percent of the restoration target set by the CEPRA 2004 plan update for the lower Neches River (GLO, 2004). Further information pertaining to this BU feature can be found in subsection 2.5.3.2.

Construction of mitigation measures in Louisiana would use sediment obtained from nearby waterbodies to restore marsh. The Willow Bayou Mitigation Measure would use sediment obtained from dredging the bottom of Sabine Lake to restore soils and marsh elevation to open-water areas in the marsh east of Sabine Lake. A 1.8-mile-long borrow trench in Sabine Lake would be dredged about 1,000 feet from the Sabine NWR shore and would average 1,030 feet wide by 7.5 feet deep. The borrow trench would be continuous and parallel the current shoreline; the common longshore circulation pattern in Sabine Lake is expected to eventually fill the trench with Sabine River sediments. An access channel from the GIWW near the mouth of the Sabine River would be needed for the dredge to reach the proposed borrow trench area. The exact locations of the borrow trench and access channel would be determined in consultation with the ICT after PED bottom surveys of potential locations. Black Bayou Mitigation Measures LA 3-15B and LA 3-18B would hydraulically dredge accumulated material from the 30-foot-deep Lake Charles Deepwater Channel (co-located with GIWW in Louisiana) and use it to restore marsh in open-water areas south of the GIWW. While changes would occur to local bathymetry and topography during construction of the proposed project, these alterations would be expected to have negligible impacts on the regional physiography of the submerged and subaerial portions of the study area. No impacts associated with geologic hazards are expected, and impacts on local geology are expected to be minimal.

4.4 WATER QUALITY

4.4.1 No-Action Alternative

Under the No-Action Alternative, there would be no construction dredging; therefore, there would be no new work material for placement. While no turbidity or possibility for the release of undesired chemicals would occur, there would also be no opportunity for the creation of marshes using dredged material beneficially.

Under the No-Action Alternative, water quality would be as it is presently, as described in Section 3.3, with a gradual increase in salinity from RSLR in the future without the proposed project. There would be short-term increases in turbidity and the possibility of release of undesired chemicals during maintenance dredging, as there is now. All maintenance material is currently placed into PAs or ODMDSs.

4.4.2 Preferred Alternative

USACE has received §401 State Water Quality Certification from Texas and Louisiana for this action. A CWA §404(b)(1) evaluation of the proposed action, provided in Appendix E, describes the effects of the proposed discharges. All relevant sediment and water quality data for both new work and maintenance dredging material were reviewed by a team of State and Federal resource agencies (ICT CW), including the TCEQ and LDEQ, and they found no cause for concern over water or sediment quality in any channel reach. New work sediments were deemed suitable for use in constructing restoration or mitigation sites, BU features, placement in ODMDSs, and upland confined PAs. Maintenance material would be handled according to the DMMP. The DMMP measures, to the greatest degree possible, the use of dredged material as a beneficial resource. The Gulf Shore BU feature shares the material from Sabine Pass equally between the states. The new work and maintenance material used in the BU features of the Preferred Alternative would allow the restoration of approximately 4,958 acres of emergent marsh in Texas. It would also be used for beach nourishment on Texas and Louisiana Points.

The Preferred Alternative is the least environmentally damaging practicable alternative. As noted above, there should be little, if any, difference in inland turbidity or DO levels between the No-Action

Alternative and the Preferred Alternative. Best Management Practices would be employed during construction of restoration and mitigation areas. Significant detrimental environmental effects have not been noted in past construction and maintenance operations and are not expected with the Preferred Alternative since much of the construction and maintenance material would be used beneficially, and the rest would go into PAs or ODMDSs. Short-term increases in turbidity may be caused by the unconfined flow of dredged material during construction of BU features and mitigation measures. There would be temporary, minor impacts from ocean placement at the new proposed ODMDSs, as discussed in detail in Appendix B. Temporary water quality impacts may occur during borrow trench and access channel dredging in Sabine Lake and the Lake Charles Deepwater Channel for mitigation measures (see also sections 5.5.1, Willow Bayou Mitigation, and 5.5.2, Black Bayou Mitigation).

There is the possibility of contamination of the maintenance material by a spill or other event, as there is now, but deepening of the channel should reduce the probability of a spill by reducing the number of vessel trips. Additionally, the USACE routinely tests the elutriates prepared from maintenance material according to ITM and RIA protocols before dredging to ensure that there is no contamination. As noted in Section 3.3, past Tier I, Tier II, and Tier III evaluations of maintenance material elutriates with chemical analyses and water column bioassays have indicated no cause for concern.

4.5 SEDIMENT QUALITY

4.5.1 Surficial Sediments

4.5.1.1 No-Action Alternative

There would be no change in the quality of the surficial sediments of the project area unless there is an impact in the future without the proposed project.

4.5.1.2 Preferred Alternative

The quality of surficial sediments that would be dredged during construction of the Entrance Channel Extension is discussed in Appendix B. Extensive chemical analyses, bioassays, and bioaccumulation studies of this material were conducted in accordance with EPA Regulations and the *Ocean Testing Manual*. The data indicate that there are no causes for concern related to chemical contaminants and that these sediments are suitable for ocean placement. Similar testing was performed numerous times on maintenance material dredged from the 22-mile existing SNWW entrance channel, and these sediments were always found to be acceptable for ocean placement. The sediments to be dredged for the Extension Channel are located from 22 to 35 miles from shore, and thus are sufficiently far removed from known existing and historical sources of pollution on the inland portion of the SNWW to provide reasonable assurance that the material is not contaminated. The ICT CW (which included representatives from the EPA and USFWS) approved the use of the grab samples for SNWW bioassay and bioaccumulation samples, and agreed that the materials were suitable for ocean placement.

4.5.2 Maintenance Material

4.5.2.1 No-Action Alternative

The existing maintenance material was described in Section 3.4. The quantity and quality of this material would not be expected to change with the No-Action Alternative.

4.5.2.2 Preferred Alternative

The quantity of maintenance material is expected to increase by roughly 60 percent in the SNWW with the Preferred Alternative but the quality of this material would not be expected to change. While more maintenance material is expected to be dredged with the Preferred Alternative, the source and the method of placement would not change, except that much more of the maintenance material would be used beneficially. As noted above, project actions should decrease the probability of a spill. The USACE also routinely tests the maintenance material according to ITM and RIA protocols before dredging to ensure that the material is environmentally acceptable under all applicable regulations.

4.5.3 Summary

As summarized in subsection 3.4.2, recently tested sediment quality data presented in PBS&J (2004a) and from March 2008 and April 2009 indicates no cause for concern, related to the new construction dredging and dredged material placement. Although it was identified that one reach within the Neches River contained elevated levels of PAHs within the tested sediments, the elutriate tests for those sediment sampling stations did not reveal high concentrations of PAHs. Therefore, it can be concluded that PAHs are not expected to be released during dredging and/or placement, and it can be further concluded that there are no channel reaches within the SNWW that exhibit a chemistry cause for concern.

4.6 HYDROLOGY

4.6.1 No-Action Alternative

Under the No-Action Alternative that includes 1.1 feet of RSLR, there should be an increase from the present condition in the tidal circulation and water exchange with the Gulf, and a corresponding increase in sediment transport in the navigation channels. No significant change is expected in the direction or amount of longshore sediment transport. Longshore transport and wave modeling have been performed, and a sediment budget has been prepared for the study area in conjunction with a shoreline erosion study of the Texas coast from Sabine Pass through Galveston Island (King, 2007; Morang, 2006).

Shorelines will continue to retreat due to RSLR, and the rate can be expected to increase with an increase in the rate of RSLR. The highly erodible and weakly compacted soil on Pleasure Island and the east shore of Sabine Lake would likely continue to erode from tidal currents and wind waves. Vessel-generated waves and surges would continue to accelerate the process on Pleasure Island as in the past. Existing Gulf shoreline erosion of up to 40 to 50 feet/year on the Texas shoreline (King, 2007) and an erratic pattern of accretion and erosion on the Louisiana shoreline (USACE, 2004a) would also continue, with the potential for significant increases due to climate change and sea level rise (IPCC, 2007).

The FWOP does include expected changes in water demands and supply strategies that are part of the 2007 Texas State Water Plan (TWDB, 2007) and permitted flows from upstream reservoirs. Existing Sabine River flows that are dedicated to the State of Louisiana by the Sabine River Compact are also taken into consideration.

4.6.2 Preferred Alternative

4.6.2.1 Circulation, Exchange, Inflows, Velocities

Under the Preferred Alternative, the same RSLR and inflow changes assumed in the FWOP will apply, and there would be a deeper navigation channel that will allow a greater amount of tidal circulation and exchange with the Gulf than is currently the case. The deepening project would cause only a minimal increase of water surface elevation over the study area; the average increase would be 0.8 inch (Brown and Stokes, 2009). The channel deepening results generally in increases in velocity along the entire channel; however, magnitudes are quite small, less than 0.5 foot per second in most cases (Parchure et al., 2005). The largest changes are observed in the Sabine-Neches Canal, but the absolute magnitudes are still small.

The potential for proposed project features to increase storm surge impacts in the study area was analyzed with a storm surge sensitivity analysis (Wamsley et al., 2010). The ADCIRC model was run to estimate water levels for two worst-case hypothetical storms, both with and without proposed SNWW CIP project features in place. Project features evaluated by the modeling are the deeper navigation channel, proposed PAs with maximum levee heights, and two expanded PAs. The sensitivity analysis concluded that the greatest changes would occur north of Port Arthur along the Neches River. These changes are primarily due to the proposed increase in depth of the navigation channel. All changes are local and there are no project-induced increases in surges away from the immediate vicinity of the navigation channel. Water levels in the marshes and open-water areas immediately north of the river would increase on the order of 4 to 8 inches or less. The modeling indicates some interior flooding would occur within the City of Port Arthur both with and without the project. Changes in peak surge on the order of inches should not cause any significant change in interior flooding for the with-project condition.

The Preferred Alternative for the SNWW CIP also includes ODMDS and marsh restoration measures. All of the existing and proposed ODMDSs are located several miles from the Gulf shoreline in water too deep to affect wave setup on the shoreline. The influences of marsh restoration on hurricane surge have been documented by Wamsley et al. (2009a, 2009b). Surges tend to slightly increase over and just seaward of the marsh as the surge propagation is slowed, which may result in reductions in peak water levels landward of marsh features. The impact of the proposed SNWW CIP marsh restoration features are relatively small and expected to modify peak surge levels locally by a minimal amount (Wamsley et al., 2010). No significant reductions or increases in surge level would be expected from either the marsh restoration or ODMDS.

The Preferred Alternative would not have an effect on freshwater inflows to the system. However, by increasing slightly the amount of tidal exchange, the inflows would be conveyed to the Gulf marginally faster than would be the case in the No-Action Alternative.

4.6.2.2 Sediment Transport

There are two main types of sediment transport in the system—sediment carried into the channels by heavy rains in the watershed and conveyed through the navigation channels, and sediment transport along the coast. Both are addressed here.

The low velocities near the bottom of the navigation channel offer conditions favorable for sediment deposition. The amount of sediment-laden runoff would be unchanged between the FWOP and FWP (Parchure et al., 2005). The slightly larger cross sections and lower current velocities would offer slightly better conditions for sediment to settle. This is one reason why the Preferred Alternative would require more maintenance dredging than the No-Action Alternative. Another reason is that the deeper channel will have a larger volume below the existing seabed, making it function as a larger sediment trap. Furthermore, the increased length of the channel results in higher dredging quantities for the offshore channel extension. Changes in salinity that also affect shoaling quantities are discussed in a later section.

The effect on Gulf shoreline change was investigated by Gravens and King (2003). Their shoreline impact study addressed the effects of changes in the wave climate produced by the deeper offshore channel and the changes in longshore sediment transport that would be expected from the altered wave climate. Under the Preferred Alternative, a deeper and longer entrance channel would have some effect on waves moving from the Gulf to the shore, and that would in turn exert an effect on the rate of longshore sediment transport.

The Gravens and King (2003) study also addressed a 45-foot alternative and noted that the effect of the Preferred Alternative (48-foot channel) would be intermediate and somewhat less than the 50-foot alternative. The direction of sediment transport is to the west on the Texas side of the channel and to the east on the Louisiana side, with little difference between existing conditions and the 50-foot channel. The effect of channel deepening is to reduce the westward transport on the Texas side and increase the eastern transport on the Louisiana side. The effect of channel deepening is to slightly reduce the net westward transport on the Texas side and the net eastern transport on the Louisiana side.

The Gulf Shore BU Feature proposes to restore 0.86 mcy of sediment to the littoral environment every 3 years using maintenance material from dredging the Sabine Pass Channel. Material placement during each 3-year dredging cycle would alternate between Texas and Louisiana, so that material would be placed on each state's shoreline every 6 years. Some material is expected to flow into the existing marsh while the remainder would flow into nearshore waters. This recurring action would nourish eroding marsh, restore sediment to the littoral zone, minimize projected FWP shoreline impacts, and potentially create new marsh. The BU dredged material is expected to be composed largely of unconsolidated muds. The fine-grained sediments are expected to initially be highly mobile, and some portion of the material would be rapidly lost from the vicinity of the shoreline. Because of the prevailing wave climate, the mobile material within the surf zone should generally migrate to the west at both Texas and Louisiana Points (Wamsley, 2008). Transport processes identified by the Sabine Pass sediment budget (Morang, 2006) indicate that the material west of Sabine Pass would move toward the eroding shoreline at Texas Point. There, the additional fine-grained sediments could lower erosion rates through mudflat accretion and wave attenuation. A small quantity of material may migrate to the east and contribute to the Sabine Fillet at the west jetty (King, 2007; Morang, 2006). In Louisiana, the sand bar formed by BU sediments from the Cheniere LNG project may shelter the shoreline from wave energy sufficiently to allow fine-grained sediments to form a mudflat behind the sandbar (Nairn and Willis, 2002; PBS&J, 2004b). While a significant percentage of the sediment would be rapidly carried offshore, some is likely to move downcoast with the littoral current, enlarging the sand and mudflat already present at the east jetty.

4.6.2.3 Coastal Shoreline Erosion Impacts

The changes in sediment transport, while very small, can be expected to have some effect on the rates of shoreline erosion. Under the Preferred Alternative, there is a slight reduction in the erosion rate near the jetties. Near the jetties, the average rate of shoreline accretion was calculated to be as much as 60 feet/year. However, between 0.5 mile and 3 to 4 miles on either side of the jetties the erosion would be increased by less than 0.5 foot/year for a 50-foot project, and farther from the jetties than that, the change in the shoreline change would decrease to zero. The effect of the 48-foot channel on the Gulf shoreline between 0.5 mile and 3.5 miles from each jetty was estimated to be 0.42 foot/year based upon the 45- and 50-foot project effects.

The Gulf Shore BU Feature should have a positive effect on reducing shoreline erosion. The presence of additional fine-grained sediments in the littoral system, which would be provided by the BU feature, should reduce the current erosion rate and minimize the small increase in shore erosion predicted with the project. In systems that have an abundant supply of fine-grained sediments, the presence of additional muddy sediment in the nearshore environment may attenuate waves and lessen wave-induced erosion (Hsiao and Shemdin, 1980; Tubman and Suhayda, 1976; Wells and Kemp, 1986). Furthermore, the predominantly fine-grained sediment provided by this BU feature should contribute to mudflat accretion by periodically moving onshore and becoming shore-attached. On the western Louisiana and east Texas coasts, sediments accumulate as mudflats and underwater mudshoals (or “fluid mud”) in the nearshore region. Nearshore, fluid mud can be trapped against the shoreline by prevailing south and southwesterly winds, and storms carry the trapped muddy ooze onto the chenier shoreline (Morgan et al., 1958; Wells and Kemp, 1982, 1986). Accretion of the shoreline can then occur by poorly understood processes (Huh et al., 1991; King, 2007; PIE, 2003).

Although the BU sediments would be largely fine grained, approximately 18 percent of maintenance material is expected to be sand. Sands that are deposited onshore would nourish and stabilize eroding marshes, and sand deposited in the nearshore zone should stay in the nearshore environment, moving back and forth across the shoreface (Wamsley, 2008). Sand placed at Louisiana Point should remain on the shoreface where it was deposited; no significant amounts of sand are expected to enter the Jetty Channel. On erosive mud shorelines like those in the BU area, the sand percentage should increase and it would form sandy lenses or a veneer over the mud shoreline substrate. As the sand lenses thicken, the sands help protect the underlying mud from further erosion (Nairn, 1992). However, in smaller quantities, sand can also accelerate erosion of a mud beach. If the consolidated mud is not covered by a sand veneer, any sand that is mobilized by wave action would act as a scouring agent (King, 2007).

4.6.2.4 Inland Shoreline Erosion Impacts

The primary area of concern for inland shoreline impacts is Pleasure Island along the confined channels of the Port Arthur and Sabine-Neches canals (Parchure et al., 2005). No increase in the existing erosion rate is predicted with the project for the eastern shore of Sabine Lake. The primary mechanism for shoreline erosion associated with the project is from passage of large vessels. Maynord (2003) investigated the mechanisms of ship-induced bank recession (shoreline erosion). The analysis employed a numerical model (HIVEL2D) to simulate the ship-induced velocity at the bank and employed information on the vessels in the existing and future fleets and information on the speeds that would be needed in both the No-Action and Preferred alternatives. The analysis focused on two sites on Pleasure Island; the north site is in the Sabine-Neches Canal, and the south site is in the Port Arthur Canal. The north site has no existing erosion protection, while the south site has riprap protection. Neither site will have a change in channel width. The analysis was calibrated to the existing rates of bank recession, and it used the model to account for differing numbers of vessel trips projected for the years 2030 and 2060 for both the No-Action and 50-foot alternatives. The Preferred Alternative is expected to have a lesser effect than the 50-foot alternative.

Maynord (2005) found that the rates of erosion are lower for the 50-foot alternative than for the No-Action Alternative at both the north and south sites for both 2030 and 2060 traffic levels. Overall, the effect of the Preferred Alternative should be to reduce the rate of erosion on inland channels relative to the No-Action Alternative because of fewer vessel trips that are predicted with the Preferred Alternative than in the No-Action Alternative.

4.6.3 Salinity

4.6.3.1 No-Action Alternative

Under the No-Action Alternative, the modeled RSLR of 1.1 feet is expected to increase salinity levels from the present condition. RSLR is expected to increase salinities up to 2 ppt in portions of the project area in the FWOP area. The complicated circulation and salinity patterns of the SNWW system would change substantially. Freshwater enters the system via several tributaries, including the Sabine River, the Neches River, and other smaller inflows. The Neches River flows directly into Sabine Lake and the Sabine-Neches Canal. The Sabine River flows into Sabine Lake, the Sabine NWR, and into Calcasieu Lake via the GIWW. During times of low flow, the direction of flow in the GIWW is reversed and higher salinity Calcasieu waters flow westward into the Sabine basin (Gammill et al., 2002).

The Sabine-Neches Canal connects the Neches River Channel to Sabine Pass, flowing through a narrow, confined channel between Pleasure Island on the east and Port Arthur on the west. This canal conducts both fresh water from the rivers and Gulf waters intruding via tidal propagation through Sabine Pass. As a result, substantial salinity stratification forms in the Sabine-Neches Canal. Stratification contributes to salt water intruding up the Sabine-Neches Canal, into the northwest corner of Sabine Lake, and the lower reaches of the Neches River Channel. Consequently, observed salinity in Sabine Lake is highest at both the southern end (where it connects to Sabine Pass) and at the northern end (where it connects to the Sabine-Neches Canal). Lowest salinities are observed in the central and eastern portions of Sabine Lake, farthest from the hydraulic connection to sources of saline water.

Wide swings in salinity associated with shifts from periods of drought to high freshwater inflows would continue. Hydrologic conditions in some wetlands in the study area are managed with passive water control structures (rock weirs, flap-gate culverts, rock plugs, and rock dikes). FWOP conditions were developed using field salinity data collected with these structures in place. It is assumed these would continue to operate as they do today. A summary of water controls is below and they are described more fully in Section 3.5.

- In Louisiana, one large, rain-fed, freshwater impoundment (Pool 3) is located in the center of the SNWR, at the eastern edge of the SNWW study area (Gammill et al., 2002). A containment levee was constructed in 1951 around a large area of unbroken marsh. It is managed to hold fresh water at high levels, increasing the water-to-marsh ratio for wintering waterfowl habitat. Pool 3 was not included in the study area because it is hydrologically isolated from the surrounding wetlands. Two CWPPRA hydrologic restoration projects in the Black Bayou and Willow Bayou marshes east of Sabine Lake have been constructed (USFWS-LDNR, 2008a, 2008b). FWOP conditions in the Willow Bayou hydro-unit assume that all elements of Construction Unit 1 of the Willow Bayou Hydrologic Restoration Project are in place. The FWOP condition reflects a small reduction in the land loss rate due to the effects of the breakwater and in-situ terracing. Likewise, FWOP conditions in the Black Bayou hydro-unit include the projected effects of the Black Bayou Hydrologic Restoration Project. In WVA computations, land loss throughout the unit was reduced by two-thirds for the 20-year CWPPRA project life to reflect erosion protection and flow reductions with the GIWW shoreline protection. In addition, FWOP salinity in the intermediate marshes was expected to increase to 4.2 to 5.1 ppt, the salinity level projected to result from the Black Bayou hydrologic management measures (rock dike, rock weirs, and self-regulating tide gate).
- In Texas, saltwater barriers restrict saltwater intrusion from the GIWW into Taylor Bayou to the north and into the J.D. Murphree WMA to the south. Low rock weirs restrict flow on some smaller channels in the Texas Point NWR. FWOP conditions for the GIWW North, Salt Bayou, and Texas Point hydro-units were developed using field salinity data collected with these structures in place. Restrictions to the access of marine organisms caused by these structures were reflected in the EMCM variable (V_6) for aquatic organism access.

Mean salinities used in the FWOP condition of the WVA model are presented in tables 4.6-1 (Mean Salinity at Median Inflow) and 4.6-2 (Mean High Salinity at Median Inflow). The tables show salinities modeled at field sampling stations, and include a range of salinities calculated for the 95 percent confidence level. In general, empirical salinity data were used, when available, for the FWOP salinity parameter in the WVA model. HS model output was used when empirical data were not available. For marshes inland and far from model nodes, the salinity gradient was estimated based upon empirical data from adjacent hydro-units, and local resource managers' knowledge of the magnitude of water exchange with the larger channels and waterbodies.

Table 4.6-1
FWOP and FWP Mean Salinities and 95 Percent Confidence Range

Mean Salinity (ppt)/Median Flow					
				FWP Mean Salinity 95% Confidence Range	
Station Number	Data Collection Station	FWOP Mean Salinity	FWP 48-Foot Project Mean Salinity	Salinity (–2 SD)	Salinity (+2 SD)
1	Upper Neches River	0.0	0.0	0.0	0.0
2	Beaumont Turning Basin	0.1	0.2	0.0	0.7
3	Mouth of Neches River	3.4	4.2	2.9	5.5
5	Sabine River at Orange	0.4	0.6	0.0	1.5
6	Sabine-Neches Canal	12.8	14.4	12.0	16.8
7	Mouth of Sabine Pass	22.7	22.9	20.8	24.9
9	Mouth of Sabine River	5.3	6.6	5.2	8.1
10	South Sabine Lake	10.4	11.6	9.8	13.4
11	Black Bayou	4.1	5.2	3.7	6.6
14	Mouth of Johnson's Bayou	5.1	6.7	5.5	7.9
15	Keith Lake Fish Pass	14.6	16.0	14.8	17.2
16	Mouth of Willow Bayou	4.3	5.7	4.5	6.9
17	GIWW West at Taylor Bayou	13.0	14.6	13.0	16.3

Table 4.6-2
FWOP and FWP Mean High Salinities and 95 Percent Confidence Range

Mean High 33 Percent Continuous Salinity (ppt)/Median Flow					
				95% Confidence Range	
Station Number	Data Collection Station	FWOP Mean High Salinity	FWP Mean High Salinity	Salinity (–2 SD)	Salinity (+2 SD)
1	Upper Neches River	0.0	0.0	0.0	0.1
2	Beaumont Turning Basin	0.2	0.6	0.4	0.9
3	Mouth of Neches River	8.0	9.4	8.6	10.3
5	Sabine River at Orange	1.1	1.7	0.5	2.9
6	Sabine-Neches Canal	20.5	21.3	19.6	22.9
7	Mouth of Sabine Pass	27.6	27.6	26.4	28.7
9	Mouth of Sabine River	11.8	13.7	12.6	14.8
10	South Sabine Lake	17.5	18.7	16.3	21.1
11	Black Bayou	9.5	11.2	9.7	12.7
14	Mouth of Johnson’s Bayou	10.5	12.7	11.9	13.5
15	Keith Lake Fish Pass	21.2	22.1	20.9	23.4
16	Mouth of Willow Bayou	8.7	10.6	8.3	13.0
17	GIWW West at Taylor Bayou	20.2	21.0	20.1	21.9

Although expected to occur only infrequently, when low flows, considered drought flows for the purpose of this analysis, occur during late summer and fall of some years, the HS model predicts substantially higher salinities (Table 4.6-3 Mean Salinity at Low Inflow). The HS model defines drought conditions as the 10th percentile of the WAM Run 8 2060 flows. At the upper reaches of the Neches River, the relative salinity increase as a result of low inflow is relatively small, only 0.1 ppt under the FWOP condition. Salinity in the Sabine River at Orange would increase from 3.8 ppt under the modeled existing condition to 4.9 ppt under the FWOP condition. The HS model predicts salinities throughout the remainder of the project area would range from 0.5 to 2.2 ppt higher during droughts under the FWOP condition than under existing conditions. Modeled FWOP salinity at Black Bayou during median flow is 4.1 ppt increasing to 15.6 ppt under drought conditions. Likewise, at the mouth of Willow Bayou, the predicted salinity increases from 4.3 ppt at median inflows to 14.6 ppt during drought under the FWOP condition. The HS model analysis (Brown and Stokes, 2009) reports that the largest salinity differences would occur in the Neches River near Bessie Heights and along the western shore of Sabine Lake. These analyses indicate that drought conditions cause substantial increases in salinity in the project area and that RSLR associated with the FWOP condition has relatively little additional affect on salinity during droughts.

Table 4.6-3
Mean Salinity Predicted by the Hydrodynamic-Salinity Model*

Mean Salinity (ppt)/Low Flow						
					FWP Mean Salinity Range	
Station Numbers	Data Collection Station	Modeled Existing Condition	FWOP Mean Salinity	FWP 48-Foot Project Mean Salinity	Salinity (–2 SD)	Salinity (+2 SD)
1	Upper Neches River	0.0	0.1	0.26	0.0	0.6
2	Beaumont Turning Basin	1.0	1.9	2.6	2.2	3.0
3	Mouth of Neches River	11.4	13.6	14.0	13.3	14.7
5	Sabine River at Orange	3.8	4.9	5.8	4.8	6.8
6	Sabine-Neches Canal	23.0	24.6	24.7	23.8	25.6
7	Mouth of Sabine Pass	28.9	29.4	29.1	28.4	29.7
9	Mouth of Sabine River	15.9	17.4	18.4	18.1	18.7
10	South Sabine Lake	21.7	23.3	23.2	22.1	24.3
11	Black Bayou	14.1	15.6	16.6	16.2	16.9
14	Mouth of Johnson's Bayou	15.0	16.9	17.9	17.6	18.2
15	Keith Lake Fish Pass	24.2	25.5	25.5	24.7	26.3
16	Mouth of Willow Bayou	12.7	14.6	15.6	15.2	16.0
17	GIWW West at Taylor Bayou	22.9	24.5	24.5	24.1	25.0

* Brown and Stokes (2009) – Under low-flow conditions (based on WAM Run 8 output for 2060 [TWDB, 2007]). All conditions assume intermediate RSLR of 1.1 feet.

4.6.3.2 Preferred Alternative

4.6.3.2.1 FWP Salinity Impacts

The Preferred Alternative would deepen the navigation channel and allow more tidal circulation and exchange with the Gulf than at present. Salinity would increase in much of the system, and the salinity wedge would extend farther upstream in the Neches River Channel. Increased salinity is expected to reduce health and biological productivity of a large area of intertidal marsh in Louisiana and Texas.

Salinity changes in the SNWW estuarine system were projected with the HS model described in sections 3.1 and 4.1 of this FEIS (Brown and Stokes, 2009). The HS model also determined that the average water surface elevation would be altered slightly by the channel deepening. The water surface is lower by less than an inch at Sabine Pass. The average water surface elevation is somewhat higher in the upper reaches of the Neches River, where the average elevation increase is about 0.8 inch. The change likely results from an increase in the landward extent of tidal propagation.

Two scenarios (low flow and median flow) were developed in the HS model to evaluate changes resulting from the project (see tables 4.6-1, 4.6-2, and 4.6-3). The HS modeling indicated that the highest average salinity increases for the Preferred Alternative over the FWOP condition are found in the following locations:

Low Flow:

- Neches River, near Rose City (approximately 0.7 ppt)
- Sabine River at Orange (approximately 0.9 ppt)
- Eastern shore of Sabine Lake (approximately 1.0 ppt)

Median Flow:

- Neches River near Bessie Heights (approximately 1.8 ppt)
- Keith Lake Fish Pass (approximately 1.4 ppt)
- Eastern Shore of Sabine Lake (approximately 1.4 to 1.6 ppt)

In addition to changes in salinity and stratification within the navigation channels and Sabine Lake, salinities in interior marshes were predicted with the HS model. The hydrologic effect of smaller channels in the marshes was included and salinity gradients were projected for wetland areas set back from the primary waterbodies. Modeling results indicated that salinity increases in the interior marshes, based upon average salinities, would be 1.0 ppt higher in the marshes east of Sabine Lake, and 0.1 to 1.8 ppt higher in the Neches River marshes. Salinities in the cypress-tupelo swamps in the upper Neches and Sabine River reaches were predicted to be about 0.3 ppt and 1.0 ppt higher, respectively. Salinity impacts are not expected to result from borrowing material from Sabine Lake and the Lake Charles Deepwater Channel/GIWW (for Willow and Black Bayou mitigation measures) because the borrow areas do not connect to the Sabine River Channel or the Calcasieu Ship Channel.

The potential for salinity impacts to be magnified in areas subjected to hydrologic management was considered by the ICT during application of the WVA model. In the Black Bayou hydro-unit, the new structures would not restrict flow sufficiently to impound water and exacerbate impacts of the 1.4 ppt increase in salinity within the intermediate marsh. Flow is considered to be essentially unrestricted because of the many remaining hydrologic access points. In Willow Bayou, water control structures proposed for Construction Unit 2 were eliminated when HS modeling determined that they would be ineffective. Control structures built in Construction Unit 1 would not restrict flow sufficiently to impound water. Like Black Bayou, flow is considered unrestricted because of the many remaining hydrologic access points. In Texas, saltwater barriers on Taylor Bayou and along the GIWW are actively managed and can be opened to accept flows from the GIWW when salinity levels inside the marshes are higher than the GIWW. Furthermore, flows in and out of the marshes affected by these barriers remain through smaller drainages and the larger Keith Lake Fish Pass and Texas Bayou.

An extensive literature review conducted for the Louisiana Coastal Areas Ecosystem Restoration Study (LCA Study) documented that increases in salinity negatively affect primary productivity of selected indicator species found in typical wetlands of the Louisiana coastal zone (Visser et al., 2004). These studies used measurements of productivity, including total biomass, stem/leaf elongation, and photosynthesis, gathered in greenhouse experiments on saturated soils. Linear regression equations were developed to predict percentage changes in habitat productivity per 1 ppt salinity increase for each major coastal vegetation community, regardless of inundation. For every 1 ppt increase in salinity, total primary productivity of swamps was reduced by 8.4 percent, fresh marsh by 11.1 percent, intermediate marsh by an average of 6.8 percent, brackish marsh by 2.6 percent, and saline marsh by 2.1 percent. These relationships were used to predict land loss rate changes in the current study. The method and results of that analysis are presented in Section 4.10. Habitats in the SNWW study area are dominated by the same marsh and swamp vegetation species found in the western Louisiana coastal zone. Supporting references for salinity-related productivity changes in vegetation include:

- **Swamp** – co-dominant species bald cypress and tupelo gum (Conner et al., 1997; Megonigal et al., 1997; Mitsch et al., 1991; Pezeshki et al., 1987a, 1990)
- **Fresh marsh** – co-dominant species maidencane and bulltongue (Greiner LaPeyre et al., 2001; Hester et al., 2001; Howard and Mendelssohn, 1999; McKee and Mendelssohn, 1989; Pezeshki et al., 1987b, 1987c; Spalding and Hester, 2007; Willis and Hester, 2004)
- **Intermediate marsh** – co-dominant species bulltongue and marshhay cordgrass (Baldwin and Mendelssohn, 1998; Greiner LaPeyre et al., 2001; Howard and Mendelssohn, 1999, 2000; Pezeshki et al., 1987b; Spalding and Hester, 2007; Webb and Mendelssohn, 1996)
- **Brackish marsh** – co-dominant species marshhay cordgrass and seashore saltgrass (Bertness et al., 1992; Broome et al., 1995; Ewing et al., 1995; Greiner LaPeyre et al., 2001; Hester et al., 2001; Kemp and Cunningham, 1981; Parrondo et al., 1978; Warren and Brockelman, 1989)
- **Saline marsh** – Smooth cordgrass and blackrush (Bradley and Morris, 1992; Eleuterius, 1989; Gosselink, 1970; Linthurst and Seneca, 1981; Parrondo et al., 1978; Pezeshki and DeLaune, 1995).

4.6.3.2.2 WVA Model Evaluation of Salinity Impacts

The impact of salinity changes on the estuarine habitats in the SNWW study area was assessed with the WVA model. Optimal salinity ranges assumed by the WVA model for the various habitat types are as follows:

- Swamp and Bottomland Hardwood (≤1 ppt)
- Fresh Marsh (≤2 ppt) (upper limit of 4 ppt during March–November growing season)
- Intermediate Marsh (≤4 ppt) (upper limit of 8 ppt during March–November growing season)
- Brackish Marsh (≤10 ppt) (upper limit of 16 ppt as an annual average)
- Saline Marsh (≥9 and ≤21 ppt) (upper limit in excess of 24 ppt as an annual average)

The optimal salinity ranges in the WVA model were based upon established salinity tolerances of common vegetation communities and salinity ranges associated with life history requirements of fish and wildlife species utilizing the habitats. Information from 32 HSI species models (USFWS, 1980) for estuarine fish and shellfish, reptiles and amphibians, birds and mammals was relied upon in establishing the optimal ranges (USFWS, 2002a).

The WVA model assumes that periods of high salinity are most detrimental in fresh/intermediate marsh and swamp when they occur during the growing season. This assumption is supported by a recent summary of annual primary productivity by season and habitat type that was developed for the habitat-switching module of the LCA Study (Visser et al., 2004). In swamps, 75 percent of annual primary productivity occurs from March 1 through June 30, and no primary production occurs from November 1 through February 28 (Keeland and Sharitz, 1995). The seasonal productivity of fresh marsh is longer, with approximately 38 percent of annual productivity occurring from March 1 through June 30, and 48 percent occurring from July 1 through October 31 (Sasser and Gosselink, 1984). Seasonal productivity of intermediate marsh is very similar to that of fresh marsh, with somewhat lower productivity in the July through October months (Hopkinson et al., 1978).

Median flow has been used to model the effects of FWP salinity changes for all vegetative communities. Run 8 of the TCEQ's WAM was used to represent the median-flow condition for salinity modeling. The TWDB (2007) projected flows for the year 2060 by modifying Run 8 "to include projected increased demand from existing water rights, expected change to return flows, projected new strategies to come online before 2060, and estimated year 2060 storage capacities for major reservoirs" (TWDB, 2007). These WAM Run 8 inflows were developed using current patterns of precipitation and evaporation. The median-flow condition was modeled for the period from approximately April through September.

Model output included mean salinities used to model impacts to brackish and saline wetlands during their growth season. These marshes are most influenced by long-term, prevailing salinity conditions. The productivity of brackish marsh is relatively stable throughout the year, with only slightly lower productivity from November 1 through February 28 (Hopkinson et al., 1978). Nearly half of the annual productivity of saline marsh occurs from July 1 through October 31, 29 percent in late spring and summer, and 24 percent in late fall and winter.

The median flow was also used to evaluate possible effects on fresh and intermediate marshes and forested wetlands. However, because these systems are more sensitive than brackish and saline wetlands to relatively small seasonal salinity changes, mean high salinity is used as the salinity parameter for the WVA models. Mean high salinity is the roaming mean of the highest 33 percent of consecutive daily salinity values during the growing season calculated for a specific period of record. This statistic is applied to model effects of high salinity during the growing season, when episodes of sufficient duration would reduce productivity of these freshwater habitats (Hester et al., 1996, 2001; McKee and Mendelssohn, 1989).

In the EMCM, effects of salinity changes are reflected most directly by two variables: V_1 (percent emergent marsh) and V_5 (salinity); however, changes in salinity can also result in changes to variables V_2 (percent SAV coverage), V_3 (marsh edge and interspersion); and V_4 (percent shallow water). The model assumes even small changes beyond the optimal salinity range of a marsh result in a small change to the land loss rate. This effect is captured in V_1 and described in relation to vegetation impacts in Section 4.10. Variable V_5 focuses on the effects of salinity on vegetation; changes within the optimal salinity ranges of each regime are not considered an impact and do not change the SI score of "1.0." However, even small salinity increases outside of the optimal range reduce the SI below “1.0.” This impact is based upon the assumption that small changes in salinity beyond the optimal range (suboptimal) for a specific hydrologic regime and its habitats affects the primary productivity of marsh grasses and forested wetlands.

FWOP and FWP salinities are presented for each hydro-unit in Texas and Louisiana in tables 4.6-4 and 4.6-5, respectively. Tables 4.6-6 and 4.6-7 present an acreage analysis by state and habitat type that identifies areas where FWOP and FWP salinities, respectively, are predicted to remain within, or extend into the suboptimal salinity range.

4.6.3.2.3 Salinity Impacts by Vegetation Community

Bottomland Hardwoods

Bottomland hardwoods in the study area are located on elevated ridges and natural river levees, as well as on upland terrace margins, most often separated from the navigation channels by fringing marsh or swamp. The study area contains 3,206 acres of bottomland hardwoods in Louisiana, and 5,458 acres in Texas. In the FWOP condition, this habitat is projected to remain within the optimal salinity range. The upper reach of the Sabine River is generally fresh, with salinity intruding only during times of drought and low freshwater inflow, or with tidal surges during hurricanes. Prevailing conditions are reflected in the median-flow scenario of the HS model, in which a FWOP salinity of 0 ppt is predicted in the Sabine River just south of IH 10. During FWP conditions, salinities would rise near the GIWW from a FWOP salinity of 2.5 ppt to a FWP salinity of 4.1 ppt. Upstream at the confluence of the Sabine and Old rivers, salinity is predicted to rise about 0.1 ppt under both the FWOP and FWP conditions.

The Sabine River watershed also contains bottomland hardwood communities located on the Texas side of the river in the Sabine Island (524 acres), Blue Elbow (189 acres), Cow Bayou (388 acres), and Adams Bayou (640 acres) hydro-units. FWOP and FWP salinity conditions for the Texas portions of Sabine Island and Blue Elbow are identical to those in Louisiana. Cow and Adams bayous enter the Sabine River south of the GIWW and receive runoff from developed areas south and west of the city of Orange. They have been rectified and deepened to provide shallow-draft access for oil field development vessels. The HS model projects FWOP mean salinity of about 0 ppt in Cow Bayou and 3.1 ppt in Adams Bayou. FWP salinities are predicted to range from about 1.0 ppt in Cow Bayou to 3.9 ppt in Adams Bayou. Although modeled salinities predicted under both the FWOP and FWP conditions are above the optimal range (≤1.0 ppt), in Adams Bayou the bottomland hardwoods are located on higher ridges or terrace margins, and are buffered from bayou salinities by intervening swamp and marsh.

In the Neches River watershed, the Neches River just south of IH 10 is normally fresh. The HS model predicts salinities in areas with bottomland hardwoods will remain near 0 in both the FWOP and FWP conditions. Several bottomland hardwood communities also occur south of IH 10 along the Neches River—1,775 acres in the Rose City hydro-unit, 293 acres in the Bessie Heights hydro-unit, and 197 acres in the Old River hydro-unit. FWOP mean annual salinities in these areas range from 0.3 ppt near Rose City to 1.5 ppt near Bessie Heights and Old River Cove. The bottomland hardwood stands are located well east of the river on the upland terrace margin and are not affected by salinity in the Neches River.

Table 4.6-4
Salinity Changes in Texas Hydro-units

#	Hydrologic Unit Name	Habitat Type	FWOP Salinity (ppt)	FWP Salinity (ppt)	FWP Net Change (ppt)
Bottomland Hardwoods (optimal salinity range ≤1 ppt)					
Neches River Watershed					
TX 1	North Neches River	Bottomland Hardwood	0.0	0.0	0.0
TX 2	Neches-Lake Bayou	Bottomland Hardwood	0.0	0.0	0.0
TX 3	Rose City	Bottomland Hardwood	0.3	0.6	0.3
TX 5	Bessie Heights	Bottomland Hardwood	1.5	2.0	0.5
TX 6	Old River Cove	Bottomland Hardwood	1.5	2.0	0.5
Sabine River Watershed					
TX 10	Cow Bayou	Bottomland Hardwood	0.0	1.0	1.0
TX 11	Adams Bayou	Bottomland Hardwood	3.1	3.9	0.8
LA/TX 1	Sabine Island	Bottomland Hardwood	0.1	0.1	0.0
Cypress-Tupelo Swamp (optimal salinity range ≤1 ppt)					
Neches River Watershed					
TX 1	North Neches River	Cypress-Tupelo Swamp	0.0	0.0	0.0
TX 2	Neches-Lake Bayou	Cypress-Tupelo Swamp	0.0	0.0	0.0
TX 3	Rose City	Cypress-Tupelo Swamp	0.3	0.6	0.3
Sabine River Watershed					
TX 10	Cow Bayou	Cypress-Tupelo Swamp	0.0	1.0	1.0
TX 11	Adams Bayou	Cypress-Tupelo Swamp	3.1	3.9	0.8
TX 12	Blue Elbow South	Cypress-Tupelo Swamp	1.1	1.7	0.6
LA/TX 1	Sabine Island	Cypress-Tupelo Swamp	0.1	0.1	0.0
LA/TX 2	Blue Elbow	Cypress-Tupelo Swamp	0.6	0.9	0.3
Fresh Marsh (optimal salinity range ≤2 ppt)					
Neches River Watershed					
TX 1	North Neches River	Fresh Marsh	0.0	0.0	0.0
TX 2	Neches-Lake Bayou	Fresh Marsh	0.0	0.1	0.1
TX 3	Rose City	Fresh Marsh	0.3	0.6	0.3
TX 4	West of Rose City	Fresh Marsh	0.2	0.6	0.4
TX 5	Bessie Heights	Fresh Marsh	1.5	2.0	0.5
TX 7	GIWW North	Fresh Marsh (Intermediate lumped)	2.5	4.1	1.6
Sabine River Watershed					
TX 10	Cow Bayou	Fresh Marsh	4.0	5.0	1.0
TX 11	Adams Bayou	Fresh Marsh	3.5	5.0	1.5
Intermediate Marsh (optimal salinity range ≤4 ppt)					
Neches River Watershed					
TX 5	Bessie Heights	Intermediate (Brackish lumped)	4.4	4.7	0.3
TX 8	Texas Point	Intermediate (Fresh lumped)	7.0	7.8	0.8
TX 13	Groves	Intermediate Marsh	4.0	5.0	1.0
Sabine River Watershed					
TX 10	Cow Bayou	Intermediate Marsh	4.0	5.0	1.0
Brackish Marsh (optimal salinity range ≤10 ppt)					
Neches River Watershed					
TX 6	Old River Cove	Brackish Marsh	11.2	13.0	1.8
TX 7	GIWW North	Brackish Marsh	10.8	12.4	1.6
TX 8	Texas Point	Brackish Marsh	9.8	10.6	0.5
Saline Marsh (optimal salinity range ≥9 to ≤21 ppt)					
Neches River Watershed					
TX 8	Texas Point	Saline Marsh	13.8	14.6	0.8

Table 4.6-5
Salinity Changes in Louisiana Hydro-units

#	Hydrologic Unit Name	Habitat Type	FWOP Salinity (ppt)	FWP Salinity (ppt)	FWP Net Change (ppt)
Bottomland Hardwoods (optimal salinity range ≤1 ppt)					
LA 1	Perry Ridge	Bottomland Hardwood	1.7	2.3	0.6
LA/TX 1	Sabine Island	Bottomland Hardwood	0.1	0.1	0.0
LA/TX 2	Blue Elbow	Bottomland Hardwood	0.6	0.9	0.3
Cypress-Tupelo Swamp (optimal salinity range ≤1 ppt)					
LA/TX 1	Sabine Island	Cypress-Tupelo Swamp	0.1	0.1	0.0
LA/TX 2	Blue Elbow	Cypress-Tupelo Swamp (Bottomland Hardwoods lumped)	0.6	0.9	0.3
Fresh Marsh (optimal salinity range ≤2 ppt)					
LA 1	Perry Ridge	Fresh Marsh	1.7	2.3	0.6
LA 7	Southeast Sabine	Fresh Marsh	2.1	2.4	0.3
LA 8	Southwest Gum Cove	Fresh Marsh	1.4	2.0	0.6
Intermediate Marsh (optimal salinity range ≤4 ppt)					
LA 1	Perry Ridge	Intermediate Marsh	4.5	5.6	1.1
LA 2	Willow Bayou	Intermediate Marsh	6.8	7.7	0.9
LA 3	Black Bayou	Intermediate Marsh	5.1	6.5	1.4
LA 4	West Johnson’s Bayou	Intermediate Marsh	5.5	7.3	1.8
LA 5	Sabine Lake Ridges	Intermediate Marsh	5.5	7.3	1.8
LA 7	Southeast Sabine	Intermediate Marsh	2.1	2.4	0.3
LA 8	Southwest Gum Cove	Intermediate (Brackish lumped)	2.8	3.9	1.1
LA 9	East Johnson’s Bayou	Intermediate (Brackish lumped)	3.8	4.8	1.0
Brackish Marsh (optimal salinity range ≤10 ppt)					
LA 2	Willow Bayou	Brackish Marsh	7.2	8.6	1.4
LA 3	Black Bayou	Brackish Marsh	4.2	5.3	1.1
LA 4	West Johnson’s Bayou	Brackish Marsh	5.3	7.0	1.7
LA 5	Sabine Lake Ridges	Brackish Marsh	7.1	8.3	1.2
LA 6	Johnson’s Bayou Ridge	Brackish Marsh	5.3	7.0	1.7
Saline Marsh (optimal salinity range ≥9 to ≤21 ppt)					
LA 5	Sabine Lake Ridges	Saline Marsh	16.6	17.3	0.7
LA 6	Johnson’s Bayou Ridge	Saline Marsh	16.6	17.3	0.7

Table 4.6-6
FWOP Optimal Salinity Range – Acreage Analysis by Habitat Type*

	Bottomland Hardwoods (acres)		Cypress-Tupelo Swamp (acres)		Fresh Marsh (acres)		Intermediate Marsh (acres)		Brackish Marsh (acres)		Saline Marsh (acres)	
	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range
Texas												
Neches River Watershed	3,717	0	5,501	0	12,592	731	37,651	344	30,469	1,832	3,262	2,446
Sabine River Watershed	1,552	0	4,656	0	2,271	103	1,522	59	0	0	0	0
Total Acres of Habitat Type	5,269	0	10,157	0	14,863	834	39,173	403	30,469	1,832	3,262	2,446
Percentage	100.0	0	100.0	0	94.6	5.4	99.0	1.0	94.2	5.8	57.1	42.9
Louisiana												
Sabine River Watershed	3,206	0	6,641	0	23,995	1,113	125,227	8,050	19,200	5,961	3,646	491
Percentage	100.0	0	100.0	0	95.6	4.4	94.0	6.0	76.3	23.7	88.1	11.9
Total Project												
Project Total – Habitat Type	8,475	0	16,798	0	38,858	1,947	164,400	8,453	49,669	7,793	6,908	2,937
Percentage	100.0	0	100.0	0	95.2	4.8	95.1	4.9	86.4	13.6	70.2	29.8

Total FWOP Project Acres Within Optimal Range = 285,040 acres (93.1%)

Total FWOP Project Acres Within Sub-optimal Range = 21,198 acres (6.9%)

*Calculated using WVA Impacts Summaries from tables 4.1-3 and 4.1-4 and Habitat Acreage from Table 7 in Appendix C.

Table 4.6-7
FWP Optimal Salinity Range – Acreage Analysis by Habitat Type*

	Bottomland Hardwoods (acres)		Cypress-Tupelo Swamp (acres)		Fresh Marsh (acres)		Intermediate Marsh (acres)		Brackish Marsh (acres)		Saline Marsh (acres)	
	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range	Within Optimal Range	Sub-optimal Range
Texas												
Neches River Watershed	3,717	0	5,501	0	12,437	886	37,641	354	30,416	1,885	3,245	2,463
Sabine River Watershed	1,552	0	4,656	0	2,262	112	1,519	62	0	0	0	0
Total Acres of Habitat Type	5,269	0	10,157	0	14,699	998	39,160	416	30,416	1,885	3,245	2,463
Percentage	100.0	0	100.0	0	93.6	6.4	98.9	1.1	94.2	5.8	56.9	43.1
Louisiana												
Sabine River Watershed	3,206	0	6,641	0	23,937	1,171	124,686	8,591	19,123	6,038	3,631	506
Percentage	100.0	0	100.0	0	95.3	4.7	93.6	6.4	76.0	24.0	87.8	12.2
Total Project												
Project Total – Habitat Type	8,475	0	16,798	0	38,636	2,169	163,846	9,007	49,539	7,923	6,876	2,969
Percentage	100.0	0	100.0	0	94.7	5.3	94.8	5.2	86.2	13.8	69.8	30.2

Total FWP Project Acres Within Optimal Range = 284,170 acres (92.8%)

Total FWP Project Acres Within Sub-optimal Range = 22,068 acres (7.2%)

*Calculated using WVA Impacts Summaries from tables 4.1-3 and 4.1-4, Habitat Acreage from tables 4.1-3 and 4.1-4, Habitat Acreage from Table 7 in Appendix C.

The HW considered potential effects of brief salinity increases by adjusting growth rates of woody and herbaceous vegetation at rates correlated to the salinity SI in the SCM. Changes in salinity were reflected with changes in variables V_1 (tree species composition), V_2 (stand maturity), and V_3 (midstory/understory coverage) in consideration of potential impacts. Trees species found in the bottomland forest community such as oaks (*Quercus* spp.), hickories (*Carya* spp.), American elm, green ash, sweetgum, boxelder, etc., are generally sensitive to even low levels of salinity. Among many other adverse effects, salinity is known to cause a reduction in seed germination, with germination in many nonhalophytes inhibited by very small percentages of salt (Kozlowski, 1997). Woody plants usually are very sensitive during emergence and young seedling stages, but become progressively more tolerant with increasing age (Shannon et al., 1994). Given the small FWP salinity increase, only small reductions in growth rates were forecast, and no AAHU losses were projected by the BHM.

Cypress-Tupelo Swamps

Cypress-tupelo swamps in the study area occur streamside or in abandoned channels or other low areas within the floodplain. Approximately 6,641 acres of cypress-tupelo swamp are located in the Louisiana portion of the study area, and 10,157 acres in the Texas portion. Large continuous stands of swamp are present in the upper reaches of both the Sabine and Neches rivers, with thousands of acres protected in the Sabine Island and Blue Elbow Swamp WMAs. Smaller, isolated stands are found in the bottoms of small drainages along the upland margins, generally buffered from exposure to higher salinities by intervening marsh. Swamps are located in the same reaches of the river systems as the bottomland hardwoods, and experience the same FWOP and FWP predicted salinity conditions. Louisiana swamps in the study area are located in the Sabine Island (5,998 acres) and Blue Elbow (643 acres) hydro-units north of IH 10. During FWOP and FWP conditions, swamps in the Sabine Island hydro-unit would experience a salinity of 0.1 ppt. In the Blue Elbow hydro-unit, predicted salinity would increase from 0.6 ppt during FWOP conditions to 0.9 ppt during FWP conditions. No impacts to swamps in these areas are expected.

Swamps in the Texas portion of the study area occur in both the Sabine and Neches river watersheds. Swamps in the Sabine Island (1,194 acres) and Blue Elbow (2,548 acres) hydro-units straddle the border between the states, and thus the salinity changes reported for Louisiana swamps in these areas are the same in Texas. These predicted salinity changes are not expected to impact swamps in these areas. Swamps also occur in three hydro-units on the Texas side of the Sabine River watershed—Blue Elbow South (689 acres), Cow Bayou (110 acres), and Adams Bayou (115 acres). In the Neches River watershed, swamps occur in the hydro-units north of IH 10 (North Neches, 2,760 acres, and Neches-Lake Bayou, 2,277 acres), and a small swamp is located south of IH 10, at the upland margin of the Rose City hydro-unit (464 acres).

Under the median-flow condition, swamps in the Blue Elbow South hydro-unit are generally fresh with predicted salinities of 1.1 ppt in the FWOP condition and 1.7 ppt in the FWP conditions. Predicted salinity increases in Cow Bayou swamps from 0.0 ppt for the FWOP condition to 1.0 ppt for the FWP condition. The predicted salinities for Adams Bayou are higher, up to 3.1 ppt for the FWOP condition and

3.9 ppt for the FWP conditions. In total, FWP salinity increases in these swamps would result in the loss of 22 AAHUs.

The habitat switching module of the LCA Ecosystem Model projects that loss of swamp acreage would not be expected to occur until average annual salinities exceed 4 ppt, based on the literature review discussed above (Visser et al., 2004). None of the increases in salinity reported for the swamps in the Sabine River watershed would be expected to result in the conversion of swamp to marsh, and therefore the same swamp acreages were entered into the FWOP and FWP conditions of the SCM worksheets.

Fresh Marshes

Fresh marshes are widespread, but represent a smaller percentage of all marsh in the study area than intermediate and brackish marshes. Approximately 25,108 acres of fresh marsh occur in the Louisiana portion of the study area, and 15,697 acres occur in the Texas portion. In general, fresh marsh occurs along the Neches River, north of the GIWW in Louisiana and Texas, and in protected interior pockets of intermediate marsh throughout the study area. In the FWOP condition, 95 and 96 percent of this habitat in Texas and Louisiana, respectively, remain within the optimal salinity range. The proportion of fresh marsh predicted to remain in Texas within optimum salinities is 95 percent, with 94 percent remaining under the FWP condition. The WVA model predicts FWP AAHU losses of 173 AAHUs in the Neches River watershed and 111 AAHUs in the Sabine River watershed.

In Louisiana, fresh marshes are located in the Perry Ridge (18,859 acres), Southeast Sabine (2,634 acres), and Southwest Gum Cove (3,615 acres) hydro-units. Located north of the GIWW, Perry Ridge is by far the largest expanse of fresh marsh in the Louisiana study area. During most of the year, the Sabine River and the GIWW are fresh in the reaches adjacent to Perry Ridge. The Vinton drainage ditch provides hydrologic access to the eastern part of this area. However, in the FWP, salinities could increase in Perry Ridge from 1.7 ppt (FWOP) to 2.3 ppt (FWP).

The Southwest Gum Cove and Southeast Sabine hydro-units are located at the eastern edge of the SNWW study area, north and south of Pool 3, respectively. The northern hydro-unit is hydrologically connected to the GIWW through the Black Bayou Cutoff, and the southern unit is hydrologically connected to Sabine Lake through Willow Bayou. Average salinities during the growing season range from 1.2 ppt in the Southwest Gum Cove marsh to 1.7 ppt in the Southeast Sabine fresh marshes. Salinity in Southwest Gum Cove is projected to rise from 1.4 ppt (FWOP) to 2.0 ppt (FWP). Located closer to the coast, salinity in the Southeast Sabine hydro-unit is projected to rise from 2.1 ppt (FWOP) to 2.4 ppt (FWP).

In Texas, most of the fresh marshes are located in the Neches River watershed. However, smaller pockets occur in the Cow Bayou (1,775 acres) and Adams Bayou (599 acres) hydro-units in the Sabine River watershed. Mean annual salinities in these smaller bayous range from 0 ppt in the uppermost reaches to 3.5 ppt near the mouth of Cow Bayou. Adams Bayou salinity averages about 2.5 ppt. The HS model predicts salinity will increase to 4.0 ppt (FWOP) and 5.0 ppt (FWP) in Cow Bayou. In Adams Bayou, modeled salinities rise to 3.5 ppt (FWOP) and 5.0 ppt (FWP). FWP salinity would move from the maximum of the fresh marsh optimal range to roughly the maximum of the optimal range for intermediate marsh in Adams Bayou.

In the Neches River watershed, all of the fresh marsh is located north of the GIWW. North of IH 10, approximately 436 acres of fresh marsh occur in the North Neches River hydro-unit, and 1,535 acres in the Neches-Lake Bayou hydro-unit. On the lower Neches River, fresh marsh occurs in the Rose City (3,327 acres), West of Rose City (492 acre), and Bessie Heights (2,147 acres) hydro-units. Nineteen percent of Rose City is open water, and a central expanse of tidally influenced mud flats is the site of eroded wetlands that were formerly fresh marsh and cypress-tupelo swamp. About half of the Bessie Heights hydro-unit is open water, averaging 2 to 3 feet in depth, that has developed in what was historically a large, mostly emergent, intermediate marsh. Salinities in these Neches River fresh marshes under the FWOP condition range from 0.0 in the North Neches River and Neches-Lake Bayou hydro-units to 1.5 ppt in Bessie Heights. Salinities would not be expected to change in the North Neches fresh marsh under the FWP condition. The greatest salinity increase projected for these marshes under the FWP condition is 0.5 ppt for the Bessie Heights marsh.

The GIWW North hydro-unit comprises three separate areas on the north side of the GIWW. All are located within the largest remaining coastal freshwater marsh in Texas (USFWS, 2005a). Most of this area is not hydrologically connected to the waterways, which form its southern and eastern boundary, the GIWW, and the Taylor Bayou Diversion Channel, respectively. FWOP salinities predicted by the HS model for the GIWW North fresh marsh average 2.5 ppt. PAs along the GIWW and levees, created when the waterways were originally dredged, serve as barriers along the banks of the waterway that protect the marshes from bank overwash. The TPWD data indicate that salinities in the fresh and intermediate marsh average 0.7 ppt. Areas selected for inclusion in the hydro-unit are likely to be affected by salinity increases associated with SNWW channel improvements. They are influenced by breaks in the levees and PAs, or through natural bayous that allow higher-salinity waters to enter the marsh system. Predicted salinity would increase to 2.5 ppt (FWOP) and 4.1 ppt (FWP) in portions of the fresh and intermediate marsh.

Intermediate Marshes

Intermediate marshes comprise the largest percentage of marshes throughout the study area, and most occur in Louisiana east of Sabine Lake. In total, approximately 133,000 acres of intermediate marsh occur in the Louisiana portion of the study area, and 39,500 acres in the Texas portion. Approximately 99 percent of Texas intermediate marsh (the majority of which is located in the Salt Bayou hydro-unit) is predicted to have salinities in the optimum range in the FWP condition. In Louisiana, about 94 percent of the intermediate marsh is predicted to have salinities in the optimum range under FWP conditions. The WVA model predicts FWP AAHU losses of 36 AAHUs in the Neches River watershed and 1,583 AAHUs in the Sabine River watershed.

In Louisiana, all but one of the hydro-units (Perry Ridge, 4,704 acres) are located south of the GIWW. Salinity in Perry Ridge intermediate marshes would rise from 4.5 ppt (FWOP) to 5.6 ppt (FWP).

Extensive intermediate marshes occur in the Louisiana portion of the study area south of the GIWW. These marshes are found in Willow Bayou (35,109 acres), Black Bayou (34,941 acres), West Johnson's Bayou (11,110 acres), Sabine Lake Ridges (9,270 acres), Southeast Sabine (5,400 acres), Southwest Gum Cove (6.605 acres), and East Johnson's Bayou (26,138 acres). The primary hydrologic connections to these marshes are the Black Bayou Cutoff/GIWW, Black Bayou/upper Sabine Lake, Willow Bayou/central Sabine Lake, and Johnson's Bayou (south-central Sabine Lake). Mean annual salinities at these hydrologic connections are 0.4 ppt in the GIWW, 2.8 ppt in Black Bayou, 4.3 ppt at Willow Bayou, and 6.3 ppt at Johnson's Bayou. However, mean annual salinities within these interior marshes are generally lower, ranging from 1.3 ppt in the northern marshes, through 2.0 ppt in the central marshes, to 6 ppt in the southern marshes. Black Bayou has the lowest projected salinity of these three marshes under the FWOP condition with a modeled salinity of 5.1 ppt and Willow Bayou has the highest with a FWOP salinity of 6.8 ppt. FWP salinities in these marshes are predicted to increase to 6.5 ppt in Black Bayou, 7.3 ppt in West Johnson's Bayou, and 7.7 ppt in Willow Bayou.

In hydro-units located farther from Sabine Lake (Southwest Gum Cove, Southeast Sabine, and East Johnson's Bayou), salinity increases of 0.3 to 1.1 ppt are expected under the FWP condition. However, salinities within the Southwest Gum Cove and Southeast Sabine hydro-units would remain within the optimal range. Salinity in East Johnson's Bayou is predicted to rise from 3.8 ppt (FWOP) to 4.8 ppt (FWP). For most of the intermediate marshes in this area, FWOP salinities during these higher-salinity periods are already at or beyond the high end of the optimal range, and FWP conditions move them further into the brackish range for at least several weeks a year.

In Texas, intermediate marshes are located on the lower Neches River (Bessie Heights – 6,913 acres, and Groves – 437 acres) and at Texas Point (1,631 acres). The Bessie Heights and Groves hydro-units are adjacent to the Neches River and fed by several hydrologic connections. Average salinity in Bessie Heights intermediate marsh is about 4.2 ppt during the growing season. Intermediate marshes in Bessie Heights are primarily located along its southern fringe, but are separated from the Neches River by upland PAs. About half of the Bessie Heights hydro-unit is open water, averaging 2 to 3 feet in depth, which has developed in a formerly large, mostly emergent, intermediate marsh. Salinity in Bessie Heights intermediate marsh is predicted to be 4.4 ppt (FWOP), increasing to 4.7 ppt (FWP). In the Groves hydro-unit, shallow, meandering streams cross the marsh and drain into the Star Lake Canal and Neches River. Mean annual salinities within the marshes themselves are close to the Neches River levels. In the portions of the Groves hydro-unit, FWP salinities are expect to rise from 4.0 ppt (FWOP) to 5.0 ppt.

At Texas Point, approximately 1,742 acres of intermediate marsh (with small pockets of fresh marsh) are located inland of the extensive brackish marsh in this hydro-unit. Marshes are hydrologically connected to the Sabine Pass Channel through Texas Bayou and a large, interconnected man-made canal. FWOP modeled salinities are 7.0 ppt. FWP salinity would increase to 7.8 ppt.

Intermediate marsh is also located along the lower third of Cow Bayou (1,144 acres) in the Sabine River watershed. Salinity under the FWP condition is projected to increase to 5.0 in parts of the Cow Bayou marshes from 4.0 ppt in the FWOP condition.

Brackish and Saline Marshes

Brackish marshes occur just inland of saline marshes along the coast and at Sabine Pass, and form fringing marsh around Sabine Lake, Keith Lake, Salt Bayou, and Old River Cove. In total, approximately 25,161 acres of brackish marsh occur in the Louisiana portion of the study area, and 32,201 acres in the Texas portion. Little to no change would be expected between the FWOP and FWP conditions with respect to the percentage of both brackish and saline marsh remaining within the optimal range. The WVA model predicts FWP AAHU losses of 131 AAHUs in the brackish marshes of the Neches River watershed and 23 AAHUs in the Sabine River watershed. For saline marsh, a FWP loss of 5 AAHUs would be expected at Texas Point, and a loss of 37 AAHUs would be expected at Louisiana Point.

In Louisiana, brackish marshes are found in the Willow Bayou (1,182 acres), Black Bayou (3,195 acres), West Johnson's Bayou (2,078 acres), Johnson's Bayou Ridge (2,744 acres), and Sabine Lake Ridges (15,962 acres) hydro-units. The hydrologic connections and mean annual salinities are generally the same as reported for intermediate marshes located east of Sabine Lake. However, brackish marshes in Sabine Lake Ridges and Johnson's Bayou Ridge are hydrologically connected to Sabine Pass through Lighthouse Bayou. Under average annual conditions, FWP salinities would remain within the optimal range (≤10 ppt), increasing an average of 1.4 ppt, and ranging from 5.3 ppt at Black Bayou to 8.6 ppt at Willow Bayou.

In Texas, brackish marshes occur in the Old River Cove (8,530 acres), GIWW North (647 acres), and the Texas Point (2,546 acres) hydro-units. About 30 percent of the Old River Cove hydro-unit is open water, and mean annual salinities are about 10.0 ppt. At GIWW North, salinity in some of the brackish marsh during late summer months is expected to rise from 10.8 ppt (FWOP) to 12.4 ppt (FWP) At Texas Point, FWOP mean salinity in the brackish marshes averages 9.8 ppt and FWP salinity is projected to rise to 10.6 ppt, just into the suboptimal range.

Saline marshes in the study area are restricted to the immediate coastal zone. In Louisiana, they occur in the Sabine Lake Ridges (3,767 acres) and Johnson's Bayou Ridge (370 acres) hydro-units. In the FWOP condition, 100 percent of this habitat in both Texas and Louisiana remains within the optimal salinity range. In Texas, 5,708 acres of saline marsh occur in the Texas Point hydro-unit. These areas are hydrologically connected to Sabine Pass and are generally protected from saltwater incursion from the Gulf by low shoreline ridges. FWP mean annual salinity is projected to rise an average of 0.8 ppt above the FWOP condition in these marshes, while remaining within the optimal range for saline marsh (≥9 and ≤21 ppt).

4.6.3.2.4 Sensitivity to Potential Salinity Changes during FWP Drought Condition

The HS model predicts salinities at 13 locations at median and low flow under the FWOP and FWP conditions (see tables 4.6-1 and 4.6-3). FWP salinities ranged from 0 to 22.9 ppt at median flows and from 0.26 to 29.1 ppt at drought flows. Salinities under the modeled existing condition during drought ranged from 0 to 28.9 ppt. The average salinity increase from FWOP to FWP conditions at the 13 stations was 1.0 ppt at median flows and only 0.5 ppt at low flows. This suggests that the relative effect of RSLR on salinities is lower as drought conditions cause salinities to increase. The greatest salinity increases from FWOP to FWP conditions at low flow were estimated for the east shore of Sabine Lake, near Rose City on the Neches River, and the Sabine River at Orange, areas where the salinity is predicted to increase 0.7 to 1.0 ppt from the FWOP to the FWP condition. Predicted salinities in the portion of Sabine Lake adjacent to the Louisiana shore are projected to reach levels ranging from 15.6 to 17.9 ppt, under the FWP drought condition compared to a range of 12.7 to 15.0 ppt under the modeled existing drought condition.

FWP salinities under drought flows would average 8.2 ppt above FWP salinities at median flows. FWOP salinities under drought flows would average 8.9 ppt higher than FWOP salinities under median flows. Drought flows in the upper Neches River and Sabine River under the FWP condition are not likely to affect marshes in these areas since predicted salinities in the upper Neches River would be 2.6 and 5.8 ppt in the Sabine River at Orange. Salinities in adjacent marshes would be expected to be lower.

Possible impacts that may occur if predicted FWP salinities occur in the project area during drought will depend on the extent, frequency, and duration of low inflows. These possible impacts are difficult to predict because of the complexity of the project area ecosystem; uncertainty about future changes in major variables like inflow, temperature changes, and sea level rise; and limited understanding of ecosystem structure and function in the project area. There is currently substantial discussion in the scientific community regarding the role of tipping points in determining effects of ecosystem stressors. However, there are no current, reliable, studies describing salinity tipping points for marshes or wetlands in this part of Texas. It is clear that FWOP drought flows will substantially increase salinities above the modeled existing condition, over 8 ppt, but the FWP contribution to the additional salinity increase is small, averaging 0.5 ppt.

4.6.4 Groundwater Hydrology Impacts

4.6.4.1 No-Action

The No-Action Alternative would have no additional direct impacts to groundwater resources at or near the proposed study area beyond those that may result from existing dredging activities or placement of dredged material independent of this project. Any direct effects of those projects may result in local and regional changes (i.e., sedimentation, altered hydrology, or a relative rise in sea levels) over time and would be common to all alternatives considered in this FEIS. Their effects would be evaluated under their own environmental studies.

With the projected future effects of climate change, there is a potential for saltwater intrusion into shallow groundwater aquifers at or near the SNWW area due to a rise in sea levels. The USACE, Galveston District analyzed the potential for RSLR to affect aquifers in the study area (USACE, 2009b). If the sea level rises half an inch (0.04 foot), the freshwater/saltwater interface could potentially rise as much as 1.67 feet, which would not have a significant impact on a freshwater aquifer. However, for a 50-year assessment, sea level rise of 1.1 feet would cause the interface to rise up to 44 feet. For every foot the saltwater level rises, the height of free ground surface water reduces by a foot. As a result, the interface between saltwater and freshwater underground rises approximately 40 feet for every foot the sea level rises. This could have a significant effect on the amount of fresh water in deep aquifers in the study area with or without the proposed project.

4.6.4.2 Preferred Alternative

The potential to affect groundwater hydrology in this project is related to construction and maintenance dredged material placement in 16 existing and 2 expanded upland PAs, as proposed in the Preferred Alternative. Groundwater hydrology potential effects may result in physical (ability to infiltrate and/or contact groundwater in area aquifers) and chemical (TDS or salinity) attributes of the dredged material.

In the area, the Gulf Coast aquifer is subdivided into the Chicot aquifer (uppermost) and the underlying Evangeline aquifer, separated by differences in lithology and permeability. Higher permeabilities are usually associated with the Chicot aquifer. The Chicot aquifer has been divided into an upper unit and lower unit, separated by a clay bed in some areas and, in other areas, merged into one large mass of interbedded and interconnected sand and clay.

No effects are anticipated to the lower unit of the Chicot, any portion of the Evangeline, or the massive portions of the upper Chicot aquifers because clay barrier layers are anticipated to prevent contact with dredged material. Therefore, no adverse effects are anticipated to groundwater wells documented by the TWDB in the area counties.

Dredged material produced by construction of the Preferred Alternative would be managed in accordance with the DMMP. PAs would be able to accommodate material from both construction and maintenance dredging over the 50-year period of analysis. More details can be found in the DMMP (Appendix D). The upper stratigraphic units of the upper Chicot aquifer may become saturated from newly discharged dredged material and/or precipitation stored within the PA. With time and as material is discharged into the PA, the water would evaporate and the solids of the dredged material would compact to form a low permeability cap over the substrate within the PA. This cap, composed of new work material, would form an effective barrier to future dredged material infiltration.

SNWW dredge elutriate, water, and sediment data were collected and archived by the USACE within 5 years of this project's initiation. Data from this set collected within the area's footprint were compared to the regulatory thresholds set through Texas and Louisiana WQS. These findings are discussed in detail in sections 3.3 and 3.4. Water and sediment samples were collected at locations that are most likely to have been impacted by industrial properties undergoing remedial action. No WQS or WQC was exceeded by water or elutriate samples from any of the three sampling sites, and none of the concentrations was noticeably higher in the channel samples than the reference samples. Therefore, no adverse potential effects are expected if groundwater in the upper Chicot aquifer comes into contact with water or elutriate from construction and maintenance dredged material.

In general, water from the SNWW project area ranges in salinity from essentially zero to that of 30 ppt. Groundwater quality data from the TWDB database indicates that groundwater from water wells completed in the Chicot aquifer within the project vicinity generally has TDS concentrations less than

200 mg/L (fresh) to more than 3,000 mg/L (brackish). Most of the groundwater from the Chicot aquifer has an average TDS concentration of less than 1,500 mg/L. In general, storage of saline/brackish water on an upland impoundment would suggest that impacts to the uppermost contact with land surface could occur. Additionally, if groundwater occurs in this uppermost level, then saline/brackish water may blend with shallow-occurring groundwater. Greater permeability of the land surface would contribute to faster surface water entry into the subsurface, and potentially into the groundwater. This would suggest that impacts to groundwater may be likely during the first placement of dredged material into the PA; however, over the life of a PA, solids in the dredged material settle to the bottom and create a layer of low-permeability material. This physical barrier would, in time, minimize the intermixing of surface and groundwater in that area. Most of the PAs in the project area are existing, previously used impoundments, with an established layer of low-permeability material. Two new areas are proposed in upland areas adjacent to the Neches River where salinity levels in the navigation channel are lower overall. No domestic or livestock wells are in the vicinity of the PAs, and no reported complaints by groundwater users have been registered in the area. No prior use of the PAs has resulted in known groundwater resource impacts, and no impacts are anticipated from additional placement through this project. Salinity increases from dredged material water infiltration to the upper Chicot is not a concern.

With the projected future effects of climate change, there is a potential for saltwater intrusion into shallow groundwater aquifers at or near the proposed study area due to a rise in sea levels. These impacts would be the same as the No-Action Alternative discussed above in subsection 4.6.4.1.

4.7 HAZARDOUS, TOXIC, AND RADIOACTIVE WASTE

4.7.1 No-Action Alternative

The No-Action Alternative would have no impact on hazardous materials associated with regulated facilities in the region. However, maintenance dredging of existing ship channels and from future channel deepening and/or widening projects, in addition to the placement of dredged materials at PAs, would continue under the No-Action Alternative. In the absence of project activity, the existing historic impacts related to area industry are also expected to continue.

4.7.2 Preferred Alternative

According to a review of regulatory agency database records and interviews conducted with regional TCEQ personnel, industrial activity has caused measurable impacts to the surface water, sediment, soil, and groundwater in localized areas within the study area. However, chemical analysis of sediment and surface water samples collected from the waterway indicate that these impacts have apparently been limited to the industrial facilities and adjoining properties (PBS&J, 2002). The nature and potential for any HTRW site to impact the surrounding environment varies considerably. The majority of the regulated facilities and incident locations identified in the regulatory agency database review do not pose an environmental concern for the project. However, several facilities within the study area do pose a greater potential to impact the environment. These facilities pose a potential concern based on the nature and extent of contaminants at the site, their location relative to the PAs and the waterway, and the number of pathways in which the contaminants could reach the PAs and the waterway. The facilities that are considered priority HTRW sites of concern are summarized in Table 4.7-1; their locations on shown on Figure 4.7-1.

Table 4.7-1
Summary of Priority HTRW Sites within Sabine-Neches Waterway

Site Name	Site ID	Constituents of Concern	Media Impacted	Status
Bailey Waste Disposal Site	512	Arsenic compounds, benzene, phenols, pyridenes, naphthalenes, and chlorinated hydrocarbons	Surface water, groundwater, soil	Cleanup complete in 1998; Operation and Maintenance underway since 1999
State Marine	203	PAHs, metals	Surface water	Evaluation and cleanup are underway, but the nature and extent of contamination and the risks posed to human health and the environment are unknown
Palmer Barge Lines	548	Aluminum, barium, chromium, cobalt, iron, lead, magnesium, nickel, zinc, pesticides, VOCs, PAHs, PCP, and benzene	Surface water	Evaluation and cleanup underway since 2000; the EPA is considering various remedial alternatives
Star Lake Canal	471	Chromium, copper, PAHs, and PCBs	Surface water, sediments	Evaluation and cleanup underway since 2001, but the nature and extent of contamination and the risks posed to human health and the environment are unknown
International Creosoting	30	Arsenic, chromium, lead, creosote compounds, SVOC, and VOCs	Groundwater, sediment, soil, surface water	Clean up underway
Maintech International	410	PAHs	Groundwater, soil	Cleanup completed in 2000; undergoing Operation and Maintenance
Excell	28	TPH, benzene, toluene, ethylbenzene, and xylene	Groundwater	Investigation underway
Port of Beaumont, Beaumont Elevator	113	VOCs, herbicides, and pesticides	Groundwater, soil	Investigation underway
Woodcrest Site	584	VOCs	Soil	Investigation underway

Source: Banks Information Solutions (2002).

The USACE has determined that the 316-acre PA 17 is needed for future material disposal in conjunction with the Preferred Alternative and that PA 17 would be included in the DMMP; however, issues related to contaminated materials in a capped landfill and other waste disposal areas within this PA remain unresolved at this time. Pursuant to Department of the Army Engineering Regulation 1165-2-132, HTRW Guidance for Civil Works Projects, construction of civil works projects in HTRW-contaminated areas should be avoided. The non-Federal local sponsor has been notified that they are responsible for the investigation and remediation of HTRW issues for use of PA 17 for the project. Additional information is needed to fully identify and delineate onsite contaminants, and the EPA remedial investigations planned for the Star Lake Canal Superfund Site, which could potentially affect parts of PA 17, need to be completed. Surface and subsurface sampling and analysis would be necessary to identify and delineate contaminants of concern and to determine whether contaminates are present at levels of concern. Based upon available information at the time of this document's production, it is expected that PA 17 contaminant concerns would be resolved in time for its scheduled use in maintenance dredging; however,

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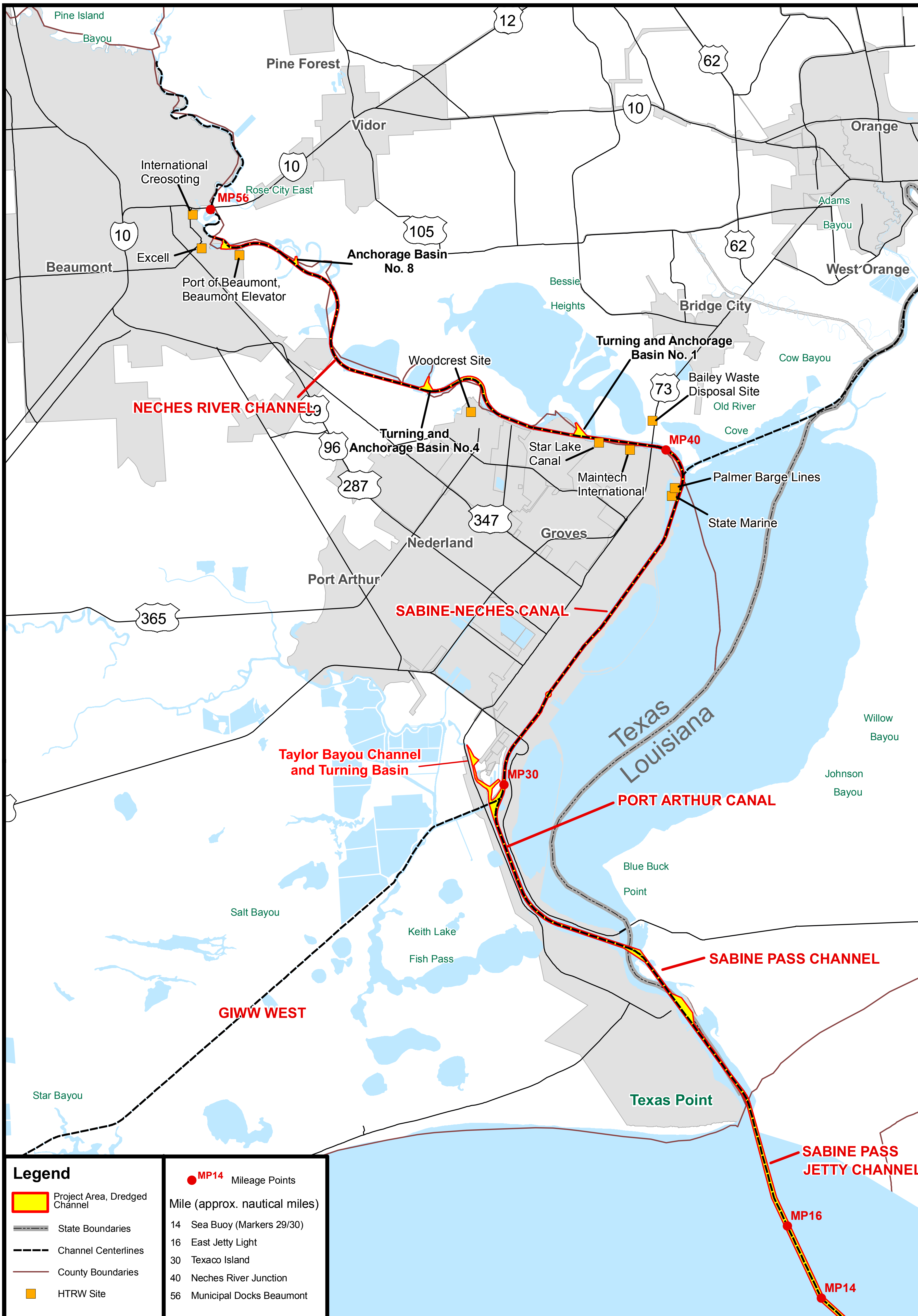

Figure 4.7-1

Priority HTRW Sites

Prepared for: USACE	
Job No.: 100007609	Scale: 1" = 3 miles
Prepared by: 18827/AP/AC	Date: 09/15/2009

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if these issues are not resolved and PA 17 is not available, National Environmental Policy Act (NEPA) analysis and coordination would be performed to designate a new PA or expand an existing PA to replace the lost capacity.

A baseline evaluation of facilities that pose a potential concern to the project must also consider whether the release of contaminants is ongoing or has been effectively eliminated through remedial efforts. Based on these criteria, State Marine, Palmer Barge Lines, Star Lake Canal, and Beaumont Elevator continue to present on ongoing threat to impact the environment of the project area since these sites have not completed remedial activities. The remaining priority sites present a lesser threat due in part to either effective corrective action or distance to the waterway.

Based on the findings of the HTRW survey, there is the potential of encountering contaminated material during construction of the project. The contaminated material could increase project cost and/or lost time from discovery and remediation of the contaminated materials within the project area. The potential of encountering contaminated material appears to be greatest in areas adjacent to priority HTRW sites and in outfall canals adjacent to the SNWW. Surveys have been conducted to locate oil and gas wells and petroleum pipelines crossing the navigation channel (PBS&J, 2005). Prior to construction, additional pipeline surveys would be necessary for proposed BU features and mitigation measures.

The highest probability of residual contamination in water and sediments would be in the area of the Star Lake Canal outfall, the northern end of Pleasure Island, and near Taylor Bayou. According to TCEQ personnel, the Star Lake Canal and Taylor Bayou convey industrial wastewater effluent and stormwater to the SNWW. The sediment adjacent to the mouths of these canals could contain elevated levels of organic and inorganic compounds. Similarly, sediment adjacent to the State Marine and Palmer Barge Lines sites located near the north end of Pleasure Island could contain a variety of organic and inorganic compounds. These sources of potential contaminants are a result of migration and runoff of impacted groundwater and surface water into the waterway. However, based upon the recent chemical analysis of water and sediment collected within these channels, the potential for encountering contaminated material during dredging operations is considered minimal.

4.8 AIR QUALITY

This section provides a discussion of the air quality impacts associated with the No-Action and Preferred alternatives. The evaluation of air quality impacts associated with the proposed SNWW CIP was based on the identification of air contaminants and estimated emission rates for the Preferred Alternative. The air contaminants considered are those covered by the NAAQS (except for lead, which is not relevant to project emissions) including CO, O_3, NO_x, PM_{10}, $PM_{2.5}$, and SO_2. Air emissions were considered for channel improvement activities and placement of dredged material as well as emissions from vehicular traffic associated with the project employee commute. Project emissions were estimated based on preliminary assumptions regarding construction timing and equipment developed for this project. It is not within the scope of this analysis to perform the refined dispersion modeling necessary to predict concentrations for each contaminant and alterative. Rather, the impact of emissions was analyzed relative to the existing inventory for air contaminant emissions in the BPA nonattainment area and the parishes of Cameron and Calcasieu.

The estimated air contaminant emissions, except O_3, were compared to the 2002 emissions inventory for the BPA ozone nonattainment area and for Cameron and Calcasieu parishes. Assuming an increase in air emissions would result in a corresponding increase in the ambient air concentration for that air contaminant, the ratio of the estimated emissions to the existing 2002 emissions for that contaminant provided a relative indication of the potential increase in ambient concentrations for the air contaminant. That difference was then compared to the NAAQS. As shown in Table 3.7-3 in subsection 3.7.3, monitored values indicate that concentrations of air contaminants (except O_3) for BPA are below the NAAQS over the period from 2004 to 2008. Because air emissions are generally dispersed with distance and time, a relatively small increase in emissions may be assumed to cause a correspondingly small increase in ambient air quality concentrations for that air contaminant, and it is therefore expected that the increase in emissions would not cause an exceedance of the NAAQS. Because authorization for the project is considered a Federal action, estimated emissions from the project were also considered in terms of the General Conformity Rules.

4.8.1 No-Action Alternative

No construction or new operating emission sources are associated with the No-Action Alternative. However, it is expected that air contaminant emissions would increase due to continued operational constraints on the existing system and projected increased ship traffic resulting both from growth of existing business and from new business.

4.8.2 Preferred Alternative

The evaluation of air quality impacts associated with the Preferred Alternative was based on the identification of air contaminants and estimated emission rates for this project alternative. Emissions inventories were estimated for project-related activities based on the schedule, dredging volumes, and other construction-related assumptions regarding construction timing and equipment developed for this project. The emission sources for this alternative would consist of marine vessel and land-based mobile sources that would be used during the channel improvement activities, as follows:

- **Marine Vessels**. Includes dredges (cutter and hopper), dredge support equipment (tugboats, survey boats, crew boats, and tenders), and shrimp trawlers; and
- **Land based.** Includes off-road (amphibious track hoe, dozer, dragline, excavator, and rolligon) and on-road (employee vehicles).

Air contaminant emissions associated with the channel widening would be primarily combustion products from fuel burned in equipment used for project dredging, support vessels, and dredged material placement equipment. Activities at dredged material placement sites would involve the use of earth-moving equipment. The marine vessel emissions sources are primarily diesel-powered engines. The off-road construction equipment was assumed to be all diesel-powered, and on-road vehicles were assumed to be all gasoline-powered vehicles. Detailed emission estimates are provided in the General Conformity Determination (Appendix F).

4.8.2.1 Air Quality Analysis Results

The project construction emissions represent the estimated emissions from the activities associated with the Preferred Alternative. These activities would be considered one-time activities, i.e., the channel widening activities would not continue past the date of completion. Because of the high moisture content of the dredged material, it is expected that there would be no particulate matter emissions from the placement of dredged material in placement areas.

A summary of the total estimated annual emissions, in tons, resulting from the use of dredging equipment, support vessels, off-road equipment, and on-road equipment is presented in Table 4.8-1. A detailed summary of emissions can be found in the General Conformity Determination (Appendix F).

The total estimated annual emissions for each year of construction were compared to the 2002 emissions inventory for the BPA nonattainment area and the emissions inventory for Cameron and Calcasieu parishes. This comparison is presented in Table 4.8-2.

As shown on Table 4.8-2, air contaminant emissions from the Preferred Alternative would result in a relatively small increase in emissions above those from existing sources in the BPA and for Cameron and Calcasieu parishes. As a result, it is expected that air contaminant emissions from the combustion of fuel in equipment used for dredging and placement activities would also result in correspondingly minor short-term impacts on air quality in the immediate vicinity of the project area and even less as emissions are dispersed over the BPA and Cameron/Calcasieu areas.

4.8.2.2 General Conformity Applicability

For comparison with the thresholds defined in the General Conformity Rule, the estimated emissions of NO_x and VOC for each year for the project activities subject to the General Conformity are summarized in tables 4.8-3 and 4.8-4. For purposes of General Conformity, only air contaminant emissions that might occur within the BPA nonattainment area out to the 9-mile natural resources limit for the State of Texas were considered. The 9 nautical mile boundary is the seaward limit of the submerged lands of Texas as defined in the Submerged Lands Act (U.S. Code Title 43, Chapter 29, Subchapter II, § 1312). Emissions of carbon monoxide, sulfur dioxide, and particulate matter are not considered in the General Conformity evaluation as this area is in attainment with the NAAQS for each of those pollutants.

Table 4.8-1
Estimated Annual Project Construction Emissions – SNWW CIP Preferred Alternative

Year 2011	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	41.56	371.87	8.42	8.89	61.61	4.21
Construction Equipment	28.74	34.67	2.74	2.82	7.27	2.92
Employee Vehicles	4.35	0.285	0.006	0.013	0.004	0.422
Subtotal	**74.65**	**406.83**	**11.17**	**11.72**	**68.87**	**7.55**
Year 2012	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	166.23	1,487.47	33.70	35.55	246.42	16.84
Construction Equipment	52.04	128.65	12.64	13.02	28.39	10.71
Employee Vehicles	19.03	1.246	0.026	0.057	0.018	1.842
Subtotal	**237.29**	**1,617.37**	**46.36**	**48.62**	**274.83**	**29.39**
Year 2013	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	167.80	1,500.92	34.00	35.87	248.65	17.00
Construction Equipment	55.84	123.20	14.69	15.13	28.42	10.28
Employee Vehicles	19.75	1.293	0.027	0.059	0.019	1.912
Subtotal	**243.38**	**1,625.41**	**48.71**	**51.06**	**277.09**	**29.19**
Year 2014	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	172.79	1,540.20	34.89	36.81	255.21	17.54
Construction Equipment	60.84	118.58	17.26	17.79	29.42	10.16
Employee Vehicles	19.44	1.273	0.027	0.058	0.018	1.883
Subtotal	**253.08**	**1,660.06**	**52.18**	**54.66**	**284.65**	**29.58**
Year 2015	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	171.41	1,513.49	34.30	36.18	250.92	17.51
Construction Equipment	60.01	106.21	18.61	19.17	28.33	8.67
Employee Vehicles	19.49	1.276	0.027	0.059	0.018	1.887
Subtotal	**250.91**	**1,620.98**	**52.93**	**55.41**	**279.27**	**28.07**
Year 2016	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	161.73	1,417.91	32.14	33.91	235.16	16.63
Construction Equipment	53.71	91.89	19.44	20.03	26.69	5.92
Employee Vehicles	19.26	1.261	0.026	0.058	0.018	1.865
Subtotal	**234.71**	**1,511.06**	**51.61**	**54.00**	**261.87**	**24.42**
Year 2017	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	155.59	1,363.78	30.92	32.61	226.19	16.00
Construction Equipment	56.96	88.30	22.47	23.16	28.10	6.10
Employee Vehicles	20.05	1.316	0.028	0.061	0.019	1.945
Subtotal	**232.60**	**1,453.40**	**53.42**	**55.84**	**254.31**	**24.05**
Year 2018	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Dredge and Support Equipment	53.29	467.93	10.61	11.19	77.60	5.47
Construction Equipment	24.74	34.07	10.49	10.81	12.07	9.07
Employee Vehicles	6.82	0.446	0.009	0.020	0.006	0.660
Subtotal	**84.84**	**502.45**	**21.10**	**22.02**	**89.68**	**15.20**

Table 4.8-2
Total Annual Project Emissions Compared with BPA/Cameron/Calcasieu 2002 Emissions Inventory

2002 EMISSION INVENTORY	CO	NO_X	$PM_{2.5}$	PM_{10}	SO_2	VOC
BPA	**134,953**	**86,242**	**10,618**	**50,702**	**39,966**	**39,913**
CAMERON/CALCASIEU	**95,016**	**68,265**	**6,319**	**13,098**	**58,397**	**34,553**
BPA/CAMERON/CALCASIEU	**229,969**	**154,507**	**16,937**	**63,800**	**98,363**	**74,467**
ANNUAL PROJECT EMISSIONS	**CO**	**NO_X**	**$PM_{2.5}$**	**PM_{10}**	**SO_2**	**VOC**
Year 2011	**74.65**	**406.83**	**11.17**	**11.72**	**68.87**	**7.55**
% of BPA	0.06	0.47	0.11	0.02	0.17	0.02
% of Cameron/Calcasieu	0.08	0.60	0.18	0.09	0.12	0.02
% of BPA/Cameron/Calcasieu	0.03	0.26	0.07	0.02	0.07	0.01
Year 2012	**237.29**	**1,617.37**	**46.36**	**48.62**	**274.83**	**29.39**
% of BPA	0.18	1.88	0.44	0.10	0.69	0.07
% of Cameron/Calcasieu	0.25	2.37	0.73	0.37	0.47	0.09
% of BPA/Cameron/Calcasieu	0.10	1.05	0.27	0.08	0.28	0.04
Year 2013	**243.38**	**1,625.41**	**48.71**	**51.06**	**277.09**	**29.19**
% of BPA	0.18	1.88	0.46	0.10	0.69	0.07
% of Cameron/Calcasieu	0.26	2.38	0.77	0.39	0.47	0.08
% of BPA/Cameron/Calcasieu	0.11	1.05	0.29	0.08	0.28	0.04
Year 2014	**253.08**	**1,660.06**	**52.18**	**54.66**	**284.65**	**29.58**
% of BPA	0.19	1.92	0.49	0.11	0.71	0.07
% of Cameron/Calcasieu	0.27	2.43	0.83	0.42	0.49	0.09
% of BPA/Cameron/Calcasieu	0.11	1.07	0.31	0.09	0.29	0.04
Year 2015	**250.91**	**1,620.98**	**52.93**	**55.41**	**279.27**	**28.07**
% of BPA	0.19	1.88	0.50	0.11	0.70	0.07
% of Cameron/Calcasieu	0.26	2.37	0.84	0.42	0.48	0.08
% of BPA/Cameron/Calcasieu	0.11	1.05	0.31	0.09	0.28	0.04
Year 2016	**234.71**	**1,511.06**	**51.61**	**54.00**	**261.87**	**24.42**
% of BPA	0.17	1.75	0.49	0.11	0.66	0.06
% of Cameron/Calcasieu	0.25	2.21	0.82	0.41	0.45	0.07
% of BPA/Cameron/Calcasieu	0.10	0.98	0.30	0.08	0.27	0.03
Year 2017	**232.60**	**1,453.40**	**53.42**	**55.84**	**254.31**	**24.05**
% of BPA	0.17	1.69	0.50	0.11	0.64	0.06
% of Cameron/Calcasieu	0.24	2.13	0.85	0.43	0.44	0.07
% of BPA/Cameron/Calcasieu	0.10	0.94	0.32	0.09	0.26	0.03
Year 2018	**84.84**	**502.45**	**21.10**	**22.02**	**89.68**	**15.20**
% of BPA	0.06	0.58	0.20	0.04	0.22	0.04
% of Cameron/Calcasieu	0.09	0.74	0.33	0.17	0.15	0.04
% of BPA/Cameron/Calcasieu	0.04	0.33	0.12	0.03	0.09	0.02

As shown in Table 4.8-3, estimated emissions of VOC for the Preferred Alternative are exempt from a General Conformity Determination because they are below the 100 tpy threshold for each year of anticipated activity. However, estimated NO_x emissions for the Preferred Alternative exceed the general conformity threshold, i.e., greater than 100 tpy, for all years of construction. Therefore, a General Conformity Determination for NO_x emissions would be required for these years.

Table 4.8-3
Summary of VOC Construction Emissions Subject to General Conformity

Year	Dredge and Support Equipment	Construction Equipment	Employee Vehicles	Total
2011	2.57	3.12	0.42	6.10
2012	12.38	11.43	1.84	25.65
2013	12.54	10.99	1.91	25.44
2014	13.82	10.86	1.88	26.57
2015	13.94	9.90	1.89	25.73
2016	14.22	8.69	1.87	24.78
2017	15.40	8.73	1.94	26.07
2018	5.47	34.89	0.66	41.02

Table 4.8-4
Summary of NO_x Construction Emissions Subject to General Conformity

Year	Dredge and Support Equipment	Construction Equipment	Employee Vehicles	Total
2011	217.77	34.05	0.29	252.11
2012	1,106.59	126.17	1.25	1,234.01
2013	1,120.03	120.72	1.29	1,242.05
2014	1,222.80	116.52	1.27	1,340.59
2015	1,208.15	104.22	1.28	1,313.65
2016	1,212.23	90.55	1.26	1,304.05
2017	1,312.36	87.97	1.32	1,401.65
2018	467.93	34.07	0.45	502.45

To initiate the General Conformity process, the USACE, prepared a document entitled, “Draft General Conformity Determination, Sabine-Neches Channel Improvement Project.” This document was noticed for public comment and was submitted by the USACE to the TCEQ, the EPA, and other air pollution control agencies, as appropriate, concurrently with the DEIS. As part of the General Conformity process, the USACE made this document available to the public for review and comment for a period of 30 days. The TCEQ has provided written concurrence that emissions from the Preferred Alternative are conformant with the Texas SIP for the BPA (Appendix A1). Based on the TCEQ's comments, the

USACE has prepared a Final General Conformity Determination for the proposed SNWW CIP (Appendix F).

4.9 NOISE IMPACTS

Project-related noise impacts were evaluated by considering the noise emissions related to dredge and placement operations of the proposed channel improvement project at noise-sensitive land uses (residential, educational, health care, recreational). Potential noise impacts associated with dredging and placement activities were evaluated by modeling predicted noise levels as a function of distance between the noise-generating equipment and noise-sensitive land uses in the vicinity of the project area. Noise levels were calculated based on industry accepted standards and properties of noise attenuation.

4.9.1 No-Action Alternative

Under the No-Action Alternative, the channel would not be deepened to project specifications. However, the existing regime of maintenance dredging, which generally includes a cutterhead suction dredge and various tending/crew boats within the channel, would continue as normal. Table 4.9-1 summarizes dredging-related noise levels produced by equipment type.

Table 4.9-1
Typical Noise Levels

Equipment	Noise Level (dBA)
Cutterhead Dredge (at 160 feet)	79[1]
Hopper Dredge (at 50 feet)	87[2]
Large Tug boat (at 50 feet)	87[3]
Small Tug Boat	72[3]
Bulldozer (at 50 feet)	82[4]
Bucket Crane (at 50 feet)	82[4]

[1] Geier & Geier Consulting (1997).
[2] Assumed same as large tug.
[3] Epsilon Associates (2006)
[4] FHWA (2006).

Potential short-term noise impacts related to the No-Action Alternative would occur during maintenance dredging activities throughout the channel's length. Noise-sensitive land uses exist in various locations along both sides of the channel's banks. These areas are concentrated in the cities of Port Arthur, Port Neches, and Beaumont. Other noise-sensitive land uses include recreational areas (J.D. Murphree State WMA, Sea Rim State Park, Sabine Pass Battleground State Park, and Pleasure Island) in the southern portion of the project. Table 4.9-2 summarizes the estimated noise levels produced by maintenance dredging activities at increasing distances from the ship channel. The No-Action Alternative would not result in permanent noise level increases, however, short-term impacts could be considered potentially significant at noise-sensitive land uses within 600 feet of maintenance dredging activities.

Table 4.9-2
Calculated Noise Levels of Maintenance Dredging

Distance From Center of Channel	Calculated Noise Level From Dredging Activities
160 feet	79 dBA (L_{eq})
300 feet	73 dBA (L_{eq})
600 feet	67 dBA (L_{eq})
1,200 feet	61 dBA (L_{eq})
2,400 feet	55 dBA (L_{eq})

4.9.2 Preferred Alternative

Under the Preferred Alternative, the channel would be deepened as described in Section 2.4. Equipment to be used for the proposed action would include separate crews consisting of a 30-inch hydraulic cutterhead dredge, three 500-horsepower tugboats, and one survey/crew boat within the channel. A large hopper dredge with tending boats would be used beyond the channel in the Gulf. However, noise levels associated with this portion of the project were not calculated since no noise-sensitive land uses are located beyond the channel. Although more than one crew could operate on the channel simultaneously, they would operate on separate reaches of the channel, and therefore would not be within the vicinity of noise-sensitive land uses at the same time. Dredging operations are expected to occur approximately 20 hours per day for a total of 7 years. Dredging activities would generate noise from a variety of equipment sources, however, the primary sources of equipment noise would include the dredges (with their associated pumps and generators) and tugboats (see Table 4.9-1). Smaller vessels, such as tending boats and survey boats, would not substantially contribute to the noise associated with dredging activities.

The proposed action under the Preferred Alternative is not expected to result in long-term noise impacts. No permanent noise sources would be installed as part of this project. In the short term, however, the proposed action could result in temporary elevated noise levels at noise-sensitive land use locations. Because the same type of equipment used for maintenance dredging would be used for the proposed action, short-term noise impacts related to the proposed action would be nearly identical to the short-term impacts that occur during current maintenance dredging, as discussed above in subsection 4.9.1. Table 4.9-2 summarizes the estimated noise levels produced by the proposed action at increasing distances from the ship channel. As is the case with current maintenance dredging, short-term impacts could be considered potentially significant at noise-sensitive land uses within 600 feet of the proposed project's dredging activities.

Reduction of the short-term noise levels could be achieved by using quieter-running equipment and by adding supplemental noise shielding around engines and pumps of the dredging equipment. Additional acoustical shielding panels could be used when the dredges operate in close proximity to residential areas. Additionally, dredging operations could be limited to daytime hours in proximity to residential areas. Limiting the hours of operation, however, would increase the length of the project significantly.

4.10 VEGETATION

4.10.1 No-Action Alternative

Under the No-Action Alternative, the combined effects of RSLR, shoreline recession, and interior marsh loss are expected to result in the significant loss of marsh and expansion of open-water areas, and this is likely to be exacerbated by the effects of global climate change. These processes would continue a trend of wetland loss that has been occurring in the study area in recent decades (Berman, 2005; Morton, 2003; Morton et al., 2005; Shinkle and Dokka, 2004; Titus and Narayanan, 1995). In Louisiana, a net land loss of 21 percent between 1978 and 2000 has been reported in the Chenier Plain subregion of coastal Louisiana, which includes the Sabine estuary (USACE, 2004a). In Texas, the most extensive losses of interior coastal wetlands in the state (12,632 acres between 1930 and 1978) have occurred in the Neches River delta. In total, over 90 percent of the emergent marshes in the Lower Neches River delta have been converted to open water, which is more than half of the total wetland loss in the State of Texas (Morton and Paine, 1990; Sutherlin, 1997; White et al., 1987). During this same period, NOAA documented a historical trend of mean sea level rise at its Sabine Pass tide gage of 0.2 inch/year over 48 years from 1958 through 2006 (USDC-NOAA, 2009), one of the highest on the Gulf Coast.

FWOP land loss projections for the SNWW project are based upon a single “most likely” estimate of 1.1 feet of RSLR by 2069. There is great uncertainty in the prediction of RSLR, which combines rates of global sea level rise and local subsidence. Uncertainties are related to the rate and degree of global climate change, including changes in the accumulation of greenhouse gases in the atmosphere, future trends in temperature and regional precipitation, the timing and quantity of freshwater inflows, sediment delivery to coastal marshes, and the rates of vegetative growth and biomass accumulation (Barras et al., 2004; IPCC, 2007; Langley et al., 2009; Nielsen-Gammon, 2009). In particular, some recent studies of geologic terrestrial and marine records support the plausibility of sea level rise on the order of 3.3 ± 1.64 feet by A.D. 2100 (Carlson et al., 2008; Rahmstorf, 2007; Rohling et al., 2008). Uncertainties in the rate of regional subsidence are related to the effect of anthropogenic factors such as oil, gas, and groundwater withdrawals, the compaction of deep reservoir rocks, the reactivation of surficial faults, and the erosion and/or accumulation of surface sediments (Gonzalez and Törnqvist, 2006; Milliken et al., 2008a, 2008b; Morton et al., 2006). This results in a very wide range of potential RSLR, calculated as stipulated by the most recent USACE relative sea level guidance (EC 1165-2-211, July 2009) to be between 0.3 and 2.8 feet over the period of analysis.

For this study, FWOP projections of land loss include the effects of rising salinities and shoreline recession associated with RSLR. Approximately 5,500 acres (7.5 percent) in Texas and 15,500 acres in Louisiana (10.5 percent) are forecast to be lost by 2069. In the near term, the marsh degradation process provides fisheries organisms with short-term benefits by releasing organic and mineral-rich sediments into the open-water system as the marsh is lost (Minello and Rozas, 2002). In the long term, the important ecological functions of the wetlands in the affected area would decline, resulting in the loss of fish and wildlife and their habitats, adverse effects on water quality, and reductions in erosion protection.

4.10.1.1 FWOP Shoreline Recession

The forecasted RSLR would result in the recession of Gulf and Sabine Lake shorelines in the SNWW study area. Potential problems associated with sea level change can be categorized into two classes; those of the open coast and large waterbodies where both water level and wave action are concerns, and those of inland tidal waters where wave action is usually much less severe (NRC, 1987). The NRC report discusses different approaches that can be used to model the change in shoreline configuration associated with RSLR. Two of those techniques were applied to project shoreline recession in the SNWW study area over the period of analysis (2019 through 2069).

The first technique is recommended for areas of active wave attack and erosion, and was applied to the Texas Gulf shoreline and the eastern shoreline of Sabine Lake. It is a historical trend analysis that includes an adjustment for higher future rates of RSLR. The second method was applied to the shorelines of interior lakes and inland waterways where the wave climate is subdued and the stable or accreting Louisiana Gulf shoreline (as described below). This method involves applying the projected change in sea level over the period of analysis to preexisting topography.

Two major factors influencing erosion and eventual shoreline profiles are fetch and exposure to predominant directions of wave approach (Wilson and Allison, 2008). In the SNWW study area, prevailing winds and wave approach are from the southeast; however, low-pressure weather systems (northers) frequently move across the upper coast from the north during winter months (Anderson, 2007). The portions of the study area most affected by these prevailing wind patterns are the Gulf shoreline and the eastern shore of Sabine Lake. In Sabine Lake, fetch and wave attack associated with prevailing southeasterly winds primarily affect the western shore, an area that is protected from erosion by riprapped levees around PAs 8 and 11. These levees are quite large and sufficiently high such that the rates of RSLR predicted here would have little to no effect. Winter northers, however, do affect the unprotected eastern shore of Sabine Lake (Greco and Clark, 2005; Parchure et al., 2005).

For the Gulf and east Sabine Lake shorelines, the historical trend, modified by the projected RSLR over the period of analysis, was used to project shoreline recession (NRC, 1987). Historical rates of change incorporate the inherent variability of the shoreline response based upon local coastal processes, local subsidence rates, coastline exposure, the local sedimentary environment, and eustatic sea level changes. This method assumes that the amount of recession during the historical record is directly correlated with the rate of sea level rise. Therefore, an accelerated rate of RSLR is assumed to result in a commensurate accelerated increase in shoreline recession. For example, a projected fourfold rise in the rate of RSLR in the study area would result in a fourfold increase in the recession rate. For the SNWW study area, the future rate of RSLR was forecast to be roughly 4.2 times the existing rate.

For this study, rates of existing historical Gulf shoreline change were obtained from several recent studies (Barras et al., 1994; BEG, 2009; USACE, 2004a). Most of the Texas shoreline in the study area experienced very high rates of shoreline retreat from the 1950s through 2002, ranging from –5 to –51 feet/year. However, small reaches near the SNWW west jetty and near Sea Rim State Park are stable or accreting. The BEG (2009) has developed a projected shoreline for the upper Texas coast for the year 2056, based upon historical Gulf shoreline changes. The historical rate of change includes historic rates of RSLR but not the accelerated rates expected in the future. The projected shoreline retreat was adjusted to account for the accelerated rate of future RSLR by multiplying the width of the BEG shoreline retreat by the projected increase in the rate of RSLR and mapping a revised shoreline with GIS, adjusted as needed for controlling features such as roadways or large chenier ridges that are likely to block retreat.

A similar method was followed for Sabine Lake; however, in this case an average annual loss rate provided by the USFWS was applied as the baseline historical rate. Erosion on the east shore of Sabine Lake is caused primarily by wind-induced waves and soft sediments (Parchure et al., 2005). The historical rate was calculated with a GIS analysis of aerial photographs taken between 1978 and 2004 (Greco and Clark, 2005). This analysis estimated an average shoreline retreat rate of 4.5 feet/year for the Sabine Lake shoreline between the Sabine River and Willow Bayou. For the purposes of this analysis, the 4.5 feet/year rate is applied to the entire east Sabine Lake shoreline as shoreline retreat is also a problem along the Sabine Lake shoreline between Willow Bayou and Blue Buck Point (LCWCR/WCRA, 1998). The 4.5-foot/year rate was increased by a factor of 4.2 to account for the accelerated rate of RSLR, resulting in an estimated 1,200 feet of shoreline retreat by the year 2069. The current shoreline was recessed by this width, except where other controlling features such as levees, cattle walkways, or roadways would block retreat, and the lost acreage was calculated by GIS.

For the Louisiana Gulf shoreline in the study area, no change was projected through the year 2050 (Barras et al., 1994). The history of shoreline change for this area, developed in conjunction with the Louisiana Coastal Areas Ecosystem Restoration Report (USACE, 2004a), documented that the segment of the Chenier Plain shoreline between Sabine Pass and Ocean View Beach (located 6 miles beyond the 10-mile SNWW study boundary) prograded seaward at an average rate of +12.9 feet/year between 1883 and 1994. Between 1985 and 1995, the average rate of progradation slowed to +1.2 feet/year. The shoreline in the study area is dominated primarily by the effect of the Sabine Pass jetties, which intercept the westward-moving littoral drift and tend to trap sediment, creating a more stable shoreline than that nearer to Ocean View Beach. For this study, a stable shoreline through the period of analysis was assumed, and the projected RSLR at the Gulf shoreline (1.1 feet in year 2069) was applied to the preexisting topography using the GIS method described below.

For the Louisiana Gulf shoreline and the shorelines of all other major waterways and waterbodies in the study area, the second method was applied. Preexisting topography along shorelines was assumed to be fixed; current shoreline elevation was combined with the projected increase in sea level to project a new shoreline. The increase in sea level at the end of the period of analysis (year 2069) is equivalent to the change in water surface elevation projected by the HS model for the FWOP with RSLR condition; this change is +1.1 feet throughout the study area. Slope is a major controlling variable in the determination of shoreline changes using this method. Steep slopes would experience little shoreline displacement while gentle slopes would show a much larger lateral change. It is assumed that man-made features such as jetties, roads and highways, dikes and levees, bulkheads and fill would continue to be maintained at a sufficient elevation that they would block shoreline retreat, and that current beneficial use projects that use dredged material to isolate interior wetlands from large waterways would be continued.

In the WVA EMCM, hydrologic unit acreages were adjusted to remove acres lost to RSLR-related shoreline recession for the FWOP land loss projection in the WVA model. This adjustment was made in the WVA land loss tables. The rate of acreage lost due to shoreline recession was assumed to be linear. The acres lost per year were subtracted from the base acreage before the revised land loss rate for the interior marsh was applied. This adjustment results in the removal of an equivalent amount of acres (lost due to RSLR only) from both the FWOP and FWP conditions. FWOP and FWP interior land loss rates were then applied to the remaining acreage, as described below, to determine the effect of salinity changes over the period of analysis in both the FWOP and FWP conditions.

In summary, the total acres of marsh forecast to be lost in the FWOP condition due to shoreline recession is 6,394 acres. The loss for each affected hydro-unit is shown in Table 4.10-1.

Table 4.10-1
Acres Lost to FWOP Shoreline Recession

HU #	HU name	Marsh Type	Marsh	Water	Total
Louisiana					
LA 2	Willow Bayou	Brackish	627	20	648
LA 3	Black Bayou	Brackish	621	9	630
LA 4	West Johnson's Bayou	Brackish	957	130	1,087
LA 5	Sabine Lake Ridges	Brackish	685	49	734
		Saline	106	33	138
	Louisiana Subtotal		2,996	240	3,236
Texas					
TX 7	GIWW North	Fresh	8	0	8
		Intermediate	4	0	4
TX 8	Texas Point	Fresh	1	0	1
		Intermediate	68	2	70
		Brackish	813	40	852
		Saline	2,043	151	2,194
TX 9	Salt Bayou	Fresh	0	0	0
		Brackish	27	3	30
	Texas Subtotal		2,962	196	3,158
Total	**Project Area**		**5,958**	**436**	**6,394**

4.10.1.2 FWOP Interior Marsh Loss

4.10.1.2.1 Interior Marsh Loss

Land loss rates for interior marsh areas were adjusted to account for increasing salinity due to RSLR over the period of analysis using the land loss methodology of the WVA and a productivity-based land loss projection methodology based upon a salinity-vegetation productivity relationship developed for the habitat productivity component of the LCA Ecosystem Model (Visser et al., 2004).

The deepening project would result in a minimal increase in water elevation over the majority of the project area (averaging less than ½ inch). Thus no FWP impacts due to water elevation increases are anticipated. It is, however, assumed that all tidally influenced habitats would see a gradual increase in water elevation associated with a RSLR of 13.2 inches by 2069.

The effects of the projected rate of RSLR on coastal marshes are very difficult to predict. The RSLR rate at which marsh will convert to open water depends on the rate of marsh elevation gain by sediment accumulation and/or biological mechanisms such as biomass accumulation (Langley et al., 2009). Dams on both the Sabine and Neches rivers have decreased sediment deposition downstream in the coastal marshes, making biological processes very important in their long-term sustainability. It is possible that biomass accumulation would offset much if not all of the RSLR change in water surface elevation. "Primary productivity of salt marsh vegetation is regulated by changes in sea level, and the vegetation, in turn, constantly modifies the elevation of its habitat toward an equilibrium with sea level (Morris et al., 2002). A rise in relative sea level brings an increase in production and biomass density that enhances sediment deposition by increasing the efficiency of sediment trapping. This can lead to an absolute increase in the elevation of the marsh platform and result in a landward migration of the marsh (Gardner et al., 1992, Gardner and Porter, 2001). This may change total wetland area, depending upon local geomorphology and anthropogenic barriers to migration, such as bulkheads, canals, etc.

Existing coastal marshes appear to have adapted to historical ranges of mean sea level, and gradual changes in RSLR. There has been a decrease in the loss rate in the Sabine-Calcasieu area from 7.0 to 2.6 square miles (17.1 to 3.3 percent) (Barras et al., 1994). Furthermore, the high rate of RSLR in this region may be ameliorating, as the average increase at the Sabine Pass tide gage was 0.3 inch/year for the 41-year period between 1958 and 1999 compared to 0.2 inch/year for the 48-year period between 1958 and 2006 (USDC-NOAA, 2006, 2009). FWOP projections of coastal land loss in the Louisiana portion of the SNWW study area forecast relatively stable landforms and shorelines through 2050 (Barras et al. 1994), not accounting for the effects of tropical storms and hurricanes. In general, the interior marshes in the Louisiana portion of the SNWW study area appear to have stabilized and are not undergoing rapid conversion of large areas to open water like areas to the east in Louisiana (LCWCR/WCRA, 1998; USACE, 2004a). Recent Louisiana LIDAR data shows that existing marsh is higher than the projected RSLR for the period of analysis and thus should be able to withstand the gradual rise in elevation (Louisiana State University, 2009).

Similar large-scale FWOP land loss projections are not available for the Texas portion of the study area. However, this study assumed that the Texas portion would also remain relatively stable with respect to the effects of RSLR through the period of analysis because the same chenier landforms, marshes, and sediments are present throughout the study area. A GIS study of aerial photographs of the Salt Bayou/Keith Lake system confirmed that the open-water trend has slowed and possibly reversed itself in that area in recent years (TPWD, 2003). Texas interior marshes most at risk to the effects of RSLR are located in the Texas Point NWR and just outside and to the west of the SNWW study area in the McFaddin NWR. Most recently, marshes in these areas have been highly stressed due to the combined effects of Hurricane Ike's storm surge and a subsequent drought, which caused prolonged high salinities throughout these marshes.

However, many different climatic, physical, and biological processes can affect the rate of accumulation. Recent experimental evidence suggests that increasing atmospheric CO_2 concentrations could stimulate biogenic mechanisms of elevation gain in a brackish marsh, and further, that this effect could be enhanced under salinity and flooding conditions expected with future RSLR (Langley et al., 2009). This response is further complicated by variations in sediment supply from river discharges and variations in primary production due to changes in nutrient loading, precipitation, temperature, and other factors (Morris et al., 2002). Gulf shoreline erosion associated with accelerated rates of RSLR may increase the amount of near shore sediment. Wilson and Allison (2008) have shown that material released by Gulf shoreline erosion remains nearshore rather than being dispersed into offshore waters, therefore remaining available for redeposition by tidal flooding or storm surge overwash. In addition to RSLR, future changes in climate would influence the quantity and timing of freshwater delivery to the coastal estuaries. At this time there is no consensus in the direction or amount of changes in precipitation in the study area, while a temperature increase of 4°F is likely by 2059 (Nielsen-Gammon, 2009). Whatever the net effect of climate change on basin runoff, most climate change projections agree that more frequent high-intensity rainfall events are likely. In most drainages, this type of event would most likely produce increased sediment runoff, and thus periodically increase sediment delivery to the coastal marshes. Uncertainties related to all of these processes could result in very different predictions of future marsh conditions.

It must be recognized that large areas of interior marsh could quickly convert to open water under certain extraordinary events. If RSLR accelerates to the extent that the coastal plant community cannot sustain an elevation within its range of tolerance, rates of primary production would decrease, resulting in an unstable and rapidly deteriorating marsh community (Morris et al., 2002). In addition, if shoreline recession cuts existing foredune formations, large areas of interior marsh could quickly be exposed to higher-salinity Gulf waters and wave attack. In this case, large marsh areas could quickly be lost to the Gulf.

The EMCM was used to forecast land loss in the emergent marshes of the study area. Variable V_1 (percent emergent marsh) of this model requires the projection of the number of acres of emergent marsh that would remain at the end of the period of analysis, both without and with the project. The WVA land loss methodology assumes that historical trends can be used to predict future land loss rates. Baseline historical land loss rates were determined by measuring changes over the most recent 15- to 20-year time period for which reliable data were available. These rates include the chronic, regional effects of subsidence, altered sediment delivery, global sea level rise, and tropical storms and hurricanes. They were calculated from a period that postdates high oil and gas extraction in the region and thus exclude subsidence that may be related to the higher rates of extraction, which have waned significantly in recent decades. After changes in acreages were calculated, the amount of emergent marsh that converted to open water was expressed as a percentage loss per year.

Increasing salinity levels associated with accelerating RSLR would be expected to reduce the primary productivity of the marsh and increase the land loss rate. Associating a decrease in primary productivity with an increase in salinity is based upon documented biological responses of inundated vegetation to salinity. The expected reduction in biological productivity of wetlands in the study area as a result of salinity stress is discussed in Section 4.6. Decreased plant productivity has been demonstrated to result from the interaction of excessive submergence and salinity. This interaction leads to a decrease in organic matter accumulation, which, in turn, results in greater submergence because the rate of increase in marsh elevation cannot keep up with the rate of submergence due to RSLR (Day and Templet, 1989; Day et al., 1995; DeLaune et al., 1994; Nyman et al., 1993; Spalding and Hester, 2007). The death of wetland vegetation often results, followed by peat collapse, erosion, and wetland loss (DeLaune et al., 1994; Gough and Grace, 1999; Salinas et al., 1986; Visser et al., 1999; Webb and Mendelssohn, 1996).

FWOP effects of RSLR to interior marsh areas are expected to be limited to the effects of increasing salinity. FWOP land loss rates were adjusted for the gradually rising salinity using the productivity-based land loss projection described below. Although emergent marshes throughout the tidally influenced portions of the study area would experience a gradual increase in water elevation associated with a RSLR of 1.1 feet by 2069, biomass accumulation was assumed to offset all of the RSLR increase in water surface elevation. The total amount of interior marsh expected to be lost in the FWOP condition, exclusive of the approximately 6,000 acres lost to shoreline recession, is approximately 15,000 acres.

4.10.1.2.2 Productivity-Based Land Loss Projection

In order to provide a science-based and systematic evaluation of the project effects for the SNWW WVA model application, the HW applied a productivity-based method of land loss projection that is based upon a salinity-productivity relationship developed for the habitat productivity component of the LCA Ecosystem Model (Visser et al., 2004). In the LCA Ecosystem Model, productivity algorithms were developed for all herbaceous and forested wetlands based on available published and unpublished data. That report documented extensive literature on the effect of salinity on the productivity of the dominant species in each of the habitats in this study area (see Section 4.6). These studies used various measurements of productivity, including total biomass, stem/leaf elongation, and photosynthesis, that were gathered using greenhouse experiments on saturated soils. To better illustrate the relationship of salinity and productivity, linear regression equations were developed that predict percentage changes in habitat productivity per 1 ppt salinity for each major coastal habitat type, regardless of inundation, as shown in Table 4.10-2. These predicted changes in primary productivity for every 1 ppt increase in salinity were used to predict land loss rate changes in the current study.

4.10.1.2.3 Assumptions and Uncertainties of the Productivity-Based Land Loss Projection

Relating changes in salinity to specific amounts of land loss is problematic. While there is extensive literature that relates increases in salinity to decreased productivity, vegetation stress, and eventual wetland loss, the USACE and the ICT are not aware of any studies that have documented specifically how much land loss is associated with specific increases in salinity. Similarly, no data are currently available that relate salinity reduction with a reduction in land loss (Visser et al., 2004). Therefore, the HW assumed a direct linear correlation between decreased primary productivity due to salinity increases and increased land loss rates due the project (see Table 4.10-2). The HW considered increasing land loss rates for salinities that changed from optimal to suboptimal conditions and, conversely, also considered decreasing land loss rates in target years 20 to 50. The latter consideration is based upon historical observations that land loss rates generally stabilize and lessen a few decades after channel deepening projects are completed. Since the effects of these considerations would generally offset one another, the HW opted for the simpler 1:1 relationship.

Table 4.10-2
Productivity-Based Land Loss Projection

Habitat Type	% Productivity Lowered and Land Loss Rates Increased per 1 ppt Increase in Salinity
Fresh marsh	11.1
Intermediate Marsh	11.4 (*Sagittaria*), 2.3 (*Spartina patens*); mean = 6.8
Brackish	2.6
Saline	2.1

The relationship between productivity decreases and land loss rate increases is assumed to be linear; thus, a 1 percent decrease in productivity translates to a 1 percent increase in the land loss rate. For example, in Table 4.10-2, the productivity of fresh marsh decreases by 11.1 percent with every salinity increase of 1 ppt for fresh marshes. This translates to an 11.1 percent increase in the land loss rate for every 1 ppt increase in salinity. The following standard formula was applied to calculate FWP rates used in the WVA land loss spreadsheets.

FWP land loss rate = (((fwp salinity ppt – fwop salinity ppt) x percent productivity decrease per habitat type) + 1) x baseline land loss rate)

4.10.1.3 FWOP SAV

The salinity change occurring with RSLR in the No-Action Alternative would be very gradual, and therefore the SAV community structure in the majority of intermediate marshes would likely change to include more salinity-tolerant species, such as widgeon-grass, pondweed (*Potamogeton pectinatus*), Eurasian watermilfoil, and freshwater eelgrass (USGS, 1997). It is expected that any SAV cover lost as a result of this change would be replaced by the salinity-tolerant SAVs continuing to grow within their tolerance range. As a result, no change in percent SAV cover would be expected during the period of analysis.

4.10.1.4 FWOP Effects of Hydrologic Management Structures

The hydrologic management of emergent tidal marsh has also been shown to contribute to land loss in nearby areas, such as the eastern section of the Sabine NWR, by increasing both salinity and the duration of inundation in managed marshes. The potential for hydrologic management in the study area to contribute to land loss is reviewed in subsection 4.6.3.2.1. None of the current hydrologic management measures in the study area (the western Sabine NWR excluding Pool 3, the Black Bayou area, the Texas Point and McFaddin NWRs) lead to long-term ponding or significant delays in the ability of the wetlands to drain after periodic salinity incursions (i.e., droughts or hurricanes), and thus no adverse FWOP impacts associated with managed marshes would be expected.

4.10.1.5 FWOP Adjustments for CWPPRA Marsh Restoration Projects

FWOP adjustments to acreages for constructed or funded CWPPRA projects in the east Sabine Lake marshes (Clark et al., 2000; USFWS and NRCS, 2008a), at Black Bayou (USFWS and NRCS, 2008b), and at Perry Ridge (USGS-NWRC, 2002a, 2002b) were applied in the WVA land loss spreadsheets as had been done previously. Acres of restored marsh were added in the FWOP and FWP marsh (acres) columns in the target year in which they were completed.

4.10.2 Preferred Alternative

4.10.2.1 FWP Effects on Cypress-Tupelo Swamps and Bottomland Hardwood

The Preferred Alternative would have no direct construction impacts to bottomland hardwoods or swamps, and the FWP “most likely” salinity levels would not result in the loss of any swamp or bottomland hardwood forest acreage. In the swamp communities, salinities would exceed the optimal range at Adams Bayou and in the Blue Elbow South hydro-unit. However, FWP salinities would not exceed 4 ppt and thus would not be high enough to result in the conversion of swamp to marsh, or in the loss of forested wetland acreage (Visser et al., 2004). Bottomland hardwoods on the upland terrace margin near the mouth of the Neches River, along Adams Bayou, and at Perry Ridge would be exposed to occasional insults of salinities exceeding the optimal range, but at levels that are insufficient to cause a significant loss of productivity.

4.10.2.2 FWP Land Loss

4.10.2.2.1 FWP Shoreline Recession

Shoreline recession along the eastern shoreline of Sabine Lake would not be affected by the proposed project (Parchure et al., 2005). The deepening project does not significantly increase tidal amplitude, velocity, or water surface elevation and thus would cause no additional recession of the lake shoreline (Brown and Stokes, 2009).

Bank erosion along the SNWW navigation channels is not expected to increase in the FWP condition, and thus would not contribute to shoreline recession over the period of analysis (Maynord, 2005). Existing erosion of navigation channel banks is caused primarily by vessel wakes. It is predicted that the deeper channel would result in slightly few vessel trips than the FWOP condition and thus not increase erosion.

FWP erosion of the Gulf shoreline is predicted to increase slightly over the FWOP condition. A deeper and longer entrance channel would have some effect on waves moving from the Gulf to the shore, and that would in turn exert an effect on the rate of longshore sediment transport (Gravens and King, 2003). It is predicted that this would result in the loss of 18 acres of Gulf shoreline within 4 miles from the jetties over the period of analysis.

4.10.2.2.2 FWP Interior Marsh Loss

FWP impacts would be expected to result when increased FWP salinities interact with FWOP submergence to cause a marginally higher land loss rate, exacerbating the process already occurring in the FWOP condition. The EMCM was used to forecast FWP land loss; rates were adjusted using the productivity-based projection to include the effect of gradually rising FWOP salinities and the abrupt FWP incremental salinity increase in TY 15 (the year of project completion). See tables 4.1-3 and 4.1-4 for the FWP impacts to wetland acres by habitat type in Louisiana and Texas, respectively, before the application of benefits from BU features.

Table 2.4-16 provides a summary of the project impact analysis and net losses/benefits after application of the BU plan benefits. In Louisiana, the WVA model forecasts that 691 more wetland acres in Louisiana would be lost over the period of analysis in the FWP condition. The highest losses are projected to occur in intermediate marsh (78.5 percent), with 8.5 percent in fresh marsh, 11 percent in brackish marsh, and 2 percent in saline marshes. Wetland losses in Louisiana are fully compensated by marsh mitigation measures described in Section 5.0. In Texas, the overall net change in wetland acreage is positive due to the benefits of the Neches River BU Feature. There is a net gain of 2,606 acres of emergent marsh, 12 percent fresh, 42 percent intermediate, and 46 percent brackish marsh.

4.10.2.2.3 FWP SAV

SAV impacts would be similar to expected changes in the FWOP condition. The SAV community structure in the majority of intermediate marshes would likely change to include more salinity-tolerant species, such as widgeon grass, pondweed, Eurasian watermilfoil, and freshwater eelgrass (USGS, 1997). An increase in salinity would occur with dredging of the Sabine Pass and Sabine Pass Jetty channels. The HS model projects that the incremental salinity increase would average 1.3 ppt near the mouths of Sabine and Keith lakes, 0.8 ppt in the east Sabine Lake marshes, 0.7 ppt on the lower Neches and Sabine rivers, and less than 0.15 ppt on the upper Neches and Sabine rivers. Since salinity change is a function of the total dredging template, the time required to reach a new FWP equilibrium would likely be considerable, ranging from a conservative minimum of several months to even a year, because each wetland would be responding to salinity inputs from multiple sources (Gary Brown personal communication, 2009). The most rapid change (on the order of 2 to 3 months) would likely occur in marshes immediately adjacent and open to tidal exchange with the navigation channel that has just been dredged. Because of the salinity effect of the existing navigation channel, wetlands adjacent to the channel are likely to contain SAVs with greater salinity tolerances, and thus would be able to adapt to the FWP change more easily.

The Neches River BU Feature and the Louisiana mitigation measures would likely cause SAV impacts because of temporary but greatly increased turbidity associated with the hydraulic placement of dredged material for marsh restoration. It was assumed that construction would result in the die-off of SAVs in the vicinity of placement activities during the year of construction, followed by quick rebounds associated with increased nutrient input, and the creation of shallow, protected ponds within the restored marsh. No seagrass would be affected by the Gulf Shore BU Feature, and no impacts to other types of submerged aquatic vegetation are expected from channel deepening. Seagrasses and other types of submerged aquatic vegetation are not found along the margins of SNWW channel because conditions conducive for SAV growth (i.e., calm waters and low turbidity) are not present.

4.10.2.2.4 Adjustments for Land Gains from BU Features and Mitigation Measures

Marsh restoration proposed as BU features or compensatory mitigation adds mineral soils to degraded areas of former marsh. The addition of denser mineral soils and the increase in marsh elevation were assumed to create a more stable landform, and the increase in the land loss rate due to the project was reduced by 50 percent in the WVA land loss change spreadsheets. Other mitigation measures that did not involve the creation of a higher, more-stable landform were modeled using a land loss rate equivalent to the FWP rate.

4.11 AQUATIC ECOLOGY

The following presents a discussion of potential impacts to freshwater and marine communities from the No-Action and Preferred alternatives. A description of each community type discussed below can be found in Section 3.10.

4.11.1 Freshwater

Freshwater fauna adapted to low-salinity environments are generally restricted to the upper reaches of the tributaries of Sabine Lake and their distribution depends on the extent of freshwater inflow into the estuary. Portions of the tidal reaches of the Neches (downstream of the saltwater barrier) and Sabine rivers generally support freshwater fishes. The Rose City Marsh and the upper reaches of Bessie Heights Marsh that are farthest from the study area are also freshwater ecosystems under normal conditions. Other predominantly freshwater streams that flow into Sabine Lake or the tidal reaches of the Neches and Sabine rivers include Taylor, Cow, Adams, and Little Cypress bayous in Texas, and Black and Johnson's bayous in Louisiana. Additional descriptions of the existing environment are provided in Section 3.10.

Sabine Lake was predominantly a freshwater-dominated ecosystem prior to early navigation improvements, subsidence, oil and gas exploration, and subsequent marsh erosion. Saltwater intrusion into the lake and its tributaries is largely responsible for the transformation of the lake into a euryhaline environment. While most of this change occurred in the early part of the twentieth century, the peripheral marshes and tributaries have continued to change as a result of saltwater intrusion, although at a much slower rate than before.

In particular, specific impacts to the freshwater ecosystems within the study area include the degradation of Bessie Heights, Rose City, and Old River Cove marshes through subsidence, intrusion of salt water, and vegetation loss, which have caused substantial conversion of freshwater marsh to open water. As the organic soils that support marsh vegetation erode because of saltwater intrusion, open-water areas expand

and exposure to salt water increases along the remaining marsh edge. This process further facilitates encroachment of salt water into the tributaries of these marsh areas. These processes also impact other freshwater marsh and tributary areas adjacent to Sabine Lake.

The Rose City Marsh presently consists of freshwater habitats. There is little or no information that describes the present state of this freshwater ecosystem or its recreational benefits. However, anecdotal information indicates that a viable freshwater community exists in the open water, channels, and tributaries of the Rose City Marsh. This area supports some recreational fishing to an unknown extent.

The movement of saline water into Bessie Height Marsh is generally greater than Rose City Marsh since it is farther downstream and has more hydraulic connections to the Neches Ship Channel. The diversity, distribution, and importance of freshwater fauna in this area are not well known but are likely spatially restricted as a result of saltwater intrusion. Species that occur in the open-water portions of Bessie Heights Marsh tend to be euryhaline.

Marshes at Old River Cove are exposed to higher salinities than all other marshes on the Neches River tidal because of their location where the Neches Ship Channel connects with the Sabine-Neches Ship Channel. Like Bessie Heights, the distribution and role of freshwater fauna in this area are not well known; however, intrusion of saline water probably restricts their diversity and distribution. Much of this area is managed by TPWD as the Old River Unit of the Neches River WMA. A 2,500-acre area of controlled, isolated wetlands covers the eastern half of the marsh. Intake and outfall canals for a large power plant draw higher-saline waters from Old River Cove and discharge them into the Neches Ship Channel just upstream of the Rainbow Bridge. Salinities west of the outfall canal tend to be lower because this area is buffered by the bank of the canal and receives lower salinity overland flow from the Bessie Heights area. Widgeon grass is abundant in shallow waters west of SH 87, but SAVs are not common east of the highway. Roadside ditches and the utility canals provide access to estuarine species.

4.11.1.1 No-Action Alternative

Two factors are likely to influence freshwater communities in the FWOP scenario. It is possible there would be a long-term reduction in freshwater inflow to the estuary since the human population of the state is expected to double during the life of the proposed project. The doubling of the population may increase demand for freshwater inflow, which may in turn result in lower freshwater inflows to the estuary. The second factor is relative sea level rise, which is predicted to continue. RSLR would gradually increase salinities in portions of the estuary. In the absence of the project and associated marsh restoration projects, the loss of freshwater marsh habitats would likely continue, in part due to continued RSLR, although RSLR is not expected to significantly change salinities in freshwater portions of the project area. Salinities would likely increase in tributaries to the estuary, causing continued conversion of fresh water to brackish marsh, in turn, favoring colonization by euryhaline species. These changes would occur slowly under most circumstances, although catastrophic changes associated with events like hurricanes might cause changes to occur more rapidly. There is considerable uncertainty regarding freshwater inflows to the estuary in the future.

4.11.1.2 Preferred Alternative

The Preferred Alternative includes the Neches River BU Feature, which is designed to restore the elevation in the Rose City, Bessie Heights, and Old River Cove marshes. The restoration efforts would likely impact short- and long-term, existing open-water communities. A significant portion of the open water of each marsh would be converted to shallow marsh with emergent vegetation. This habitat conversion should reduce intrusion of salt water into portions of those marshes.

Short-term impacts would be associated with marsh construction. Placement of dredged material might result in an initial increase in turbidity in the marsh and nearby tributaries. Increased turbidity might result in a short-term reduction in the distribution of SAV in the Rose City and Old River Cove marshes. The initial placement of dredged material would aid in reducing saltwater intrusion and would create more areas of quiescent water allowing SAV to repopulate the areas quickly after construction of the mitigation marshes.

Long-term impacts include the conversion of open-water habitat to marsh habitat. Some recreational benefits exist in the present open-water areas of the marshes. Under normal conditions, Rose City and Bessie Height marshes are essentially open-water, shallow, brackish to freshwater lakes. The marsh restoration would significantly reduce the amount of open-water area. Additionally, the freshwater ecosystem would be protected from future saltwater intrusion. Restoration efforts in this area would maintain channels, drainages, and some open water, which would greatly improve the complexity and diversity of marsh habitats and improve the ecological and recreational benefits of this marsh.

The upper reaches of the Neches and Sabine rivers and their tributaries in the study area support valuable freshwater habitats. Modeling of potential salinity intrusion into the Neches and Sabine rivers associated with the project indicated that mean salinities on the upper Neches River would remain near existing conditions over most of the study area. However, slightly higher salinities are expected in swamps and fresh marsh communities on or near the Sabine River near the GIWW and in the extensive fresh marsh north of the GIWW in Texas. These potential changes are expected to cause small reductions in the health and biological productivity of freshwater habitats. Increases in salinity are expected to cause additional stress on some fresh and intermediate marsh vegetation, over approximately 173,750 acres of fresh and intermediate marsh in Texas and Louisiana over the study area as a whole. No loss of swamp or bottomland hardwoods is projected. Reduced growth of some trees in the cypress-tupelo swamps, particularly near the Sabine River, is expected as a result of the slight increase in salinity from the project. The loss of freshwater habitat would be expected to increase access to mineral-rich sediments and organic nutrients in the short term for estuarine fauna, leading to a temporary increase in productivity. But the increased productivity would decline as the freshwater habitats disappear, eventually leading to some reduction in freshwater fauna productivity (Minello and Rozas, 2002). The Neches River BU Feature is intended to create 4,958 acres of restored emergent marsh, improved shallow-water habitat, and nourished existing marsh in Rose City East, Bessie Heights East, and Old River Cove. The Neches River BU Feature is also intended to offset the direct loss of 86 acres of freshwater wetland used for the creation of

PA 24A. Once the project, including the DMMP BU features and compensatory mitigation, leads to an overall net gain in marsh habitat, no detrimental impacts to fauna are anticipated.

4.11.2 Marine

4.11.2.1 Estuarine Habitats and Fauna

4.11.2.1.1 No-Action Alternative

Under the No-Action Alternative, estuarine habitats and fauna would continue as described in subsection 3.10.2.1. However, it should be noted that the No-Action Alternative does not imply that there would be no dredging or placement activities. Maintenance dredging will continue as it has in the past.

4.11.2.1.2 Preferred Alternative

Due to the reproductive capacity and natural variation in phytoplankton populations, short-term, localized increases in turbidity associated with dredging within the project area are not expected to be significant (Brannon et al., 1978; May, 1973; Odum and Wilson, 1962). Under most conditions, fish and other motile organisms are only exposed to localized suspended-sediment plumes for short durations (minutes to hours) (Clarke and Wilber, 2000). Should marsh communities benefit from the Preferred Alternative, finfish and shellfish would also benefit. The potential for the deepening to cause widening at the top of cut as the side slopes adjust to the new project depth has been evaluated. The present 40-foot channel has been in existence since the early 1970s and has had adequate time for the dense clay sediments to stabilize. Deepening will be performed by making a box cut in the bottom of the existing channel. Some slumping of the side slope at the base of the channel may occur as the deeper channel stabilizes, but no slumping is expected at the top of cut. Therefore, no impacts to oyster reef located adjacent to the top of cut in Sabine Pass are expected. No emergent marsh or shallow bottom is present adjacent to the top of cut.

There are one-time effects of the borrow trench and access channel in Sabine Lake and dredging of accumulated sediments in the Lake Charles Deepwater Channel. The Preferred Alternative would impact approximately 275 acres (225 acres for the borrow trench and 50 acres for the access channel) of lake bottom within Sabine Lake, a designated Louisiana Public Oyster Area. Dedicated dredging of Sabine Lake would be performed to supply sediment needed to restore 687 acres of emergent marsh, improve 167 acres of shallow water, and nourish 1,112 acres of existing marsh within the 1,966 total acres in Willow Bayou Mitigation Areas LA 2-18B and LA 2-ADD B. Approximately 3.1 mcy of material would be dredged from a 1.8-mile-long trench in Sabine Lake, located at least 1,000 feet from the Sabine NWR shore, averaging 1,030 feet wide by 7.5 feet deep. The borrow trench would be continuous and parallel the current shoreline; the common longshore circulation pattern in Sabine Lake is expected to eventually fill the trench with Sabine River sediments. An access channel, approximately 8 miles long, from the GIWW near the mouth of the Sabine River would be needed for the dredge to reach the proposed borrow trench area. The exact locations of the borrow trench and access channel would be determined in consultation with the ICT after PED bottom surveys of potential locations. Also, accumulated material would be dredged from the 30-foot Lake Charles Deepwater Channel, which is co-located with the GIWW in Louisiana (13 miles long by 125 feet wide beginning just past Pavel Island Channel and extending eastward, removing approximately 15 feet of accumulated sediment). The Lake Charles Deepwater Channel was completed in 1926 (USACE, 1998c) and the last known dredging occurred in 1940. Material would be hydraulically dredged and placed in Black Bayou Mitigation Areas LA 3-15B and 3-18B. The mitigation measure at West Black Bayou (LA 3-10R) would be constructed using maintenance material from the Sabine River Channel to Orange over a 30-year period. The Sabine River Channel dredging is a FWOP impact because it occurs as part of the normal maintenance dredging practices for the Sabine River Channel.

One-time impacts of the borrow trench and access channel dredging in Sabine Lake for the mitigation measures in Willow Bayou include an increase in water column turbidity during dredging activities; however, such effects are temporary and local. No further effects to water quality are expected. Benthic fauna would be removed due to evacuation of sediment during dredging activities; however, benthic organisms can rapidly recolonize, and no long-term effects are anticipated. Details of potential impacts from borrow trench dredging to benthos, salinity, SAV, oysters, and water quality are found in subsections 5.5.1 (Willow Bayou Mitigation) and 5.5.2 (Black Bayou Mitigation).

The potential for the removal of sediments from Sabine Lake for marsh mitigation to affect oyster reef has been evaluated. An oyster assessment was performed in 2006 (T. Baker Smith, Inc., 2006) near the area of the proposed Sabine Lake access channel and borrow trench in conjunction with an unrelated Department of Army permit application. Bottom types were found to consist of 90 percent firm mud and buried shell, 8 percent soft mud, and 0.7 percent exposed shell/reef. No live oyster reefs were found. Similar bottom types are expected in the area of the proposed access channel and borrow trench, which are located directly east of the surveyed area. Optimal salinities for oyster growth are from 10 to 15 ppt (Armstrong et al., 1987). Salinities in this area of Sabine Lake range from 1 to 6 ppt year-round, too fresh for oyster development (Fagerburg, 2003). During construction of the access channel and borrow trench, no impacts to extant live oyster reefs are likely. Nonetheless, prior to project implementation, a full water bottom assessment would be conducted by the USACE in accordance with the LDWF survey standards. This survey would be necessary in order for the LDWF to consider a waiver of compensation for impacts to the water bottoms of the Sabine Lake Public Oyster Area.

With the deepening of the channel, a small increase in salinity would be observed (see Section 4.6). Most organisms occupying these environments are ubiquitous along the Texas and Louisiana coast and can tolerate a wide range of salinities (Parker, 1965; Pattillo et al., 1997). Therefore, no adverse effects on fauna are expected due to changes in salinity that may result from the Preferred Alternative, except loss of habitat due to salinity impacts on marshes. Small increases in salinity under median-flow conditions would affect all tidally influenced brackish and saline marshes in the SNWW study area (approximately 37,000 acres). As discussed in Section 4.6, these potential changes are expected to cause small reductions in the health and biological productivity of these habitats. Increases in salinity are expected to cause additional stress on some marsh vegetation. However, since the project, including the DMMP BU features and compensatory mitigation, leads to an overall net gain in marsh habitat, no detrimental impacts to fauna are anticipated.

There is little difference in the likelihood of oil spills with the No-Action or Preferred Alternative except that inclusion of bend easings should make channel transits safer. In the unlikely event a petroleum product spill should occur, however low the probability, adult crustaceans such as shrimp and crabs and adult finfish are probably mobile enough to avoid most areas of high oil concentrations. Larval and juvenile finfish and shellfish tend to be more susceptible to oil than adults and could be affected extensively by an oil spill during their active immigration periods. Due to their lack of mobility, they are less likely to be able to avoid these areas and could be negatively impacted if a spill were to occur. Benthic fauna may be killed, but phytoplankton may be adversely or favorably affected by oil spills. It is unlikely that an oil spill in the project area would result in significant, long-term impacts to either phytoplankton or benthic communities, since these organisms have the ability to recover rapidly from a spill due primarily to their rapid rate of reproduction and to the widespread distribution of dominant species.

4.11.2.2 Offshore Habitats and Fauna

4.11.2.2.1 No-Action Alternative

Under the No-Action Alternative, Gulf habitats and fauna would continue as described in subsection 3.10.2.2 with maintenance dredging and placement of dredged material in four designated ODMDS sites.

4.11.2.2.2 Preferred Alternative

Construction excavation removes benthic organisms from their habitat and sends them through the dredge into the hopper. Most cannot be expected to survive placement in the adjacent ODMDS. However, the benthic community can rapidly recolonize, both on the channel bottom and in open-water PAs. Since the benthic community occupying the channel bottom is continually disturbed by passing ships, maintenance dredging, while it may kill the organisms dredged, is not expected to change the community living there after recolonization.

Construction of the Extension Channel would physically disturb benthic communities in the proposed channel prism. Impacts to benthic organisms during maintenance dredging are expected to be minor. While there is some recolonization between cycles, sediments in the channel are continuously disturbed by passing ships. Placement of dredged material in the offshore placement site would bury those benthic organisms incapable of escaping or burrowing up through the dredged material. Organisms that are buried must vertically migrate or die (Maurer et al., 1986). Maurer et al. (1986) demonstrated that many benthic organisms were able to migrate vertically through 35 inches of dredged material under certain conditions; however, the species present in early successional stages of recovery are not the same as those buried by the dredged material. Although vertical migration is possible, most organisms at the center of the disturbance do not survive, but survivability was shown to increase as distance from the disturbance increased (Maurer et al., 1986). Benthic organisms would not long survive placement into upland PAs.

Potential beneficial effects of the suspended material associated with dredging operations include a resuspension of nutrients, absorption of contaminants in the water column, and addition of a protective cover allowing certain nekton to avoid predation (Stern and Stickle, 1978). As with the various detrimental effects, the importance of each of these latter effects would vary among groups and with the physiochemical parameters existing at the time and location of dredging and placement operations. Material to be dredged is not contaminated and should not pose contamination issues with respect to aquatic communities. Impacts in the new ODMDSs would be the same as those in the existing ODMDSs and are not expected to be significant.

4.11.2.3 Essential Fish Habitat

4.11.2.3.1 No-Action Alternative

Under the No-Action Alternative, EFH would continue as described in subsection 3.10.2.3 with periodic maintenance dredging and dredged material placement for the existing channel.

4.11.2.3.2 Preferred Alternative

EFH for adult and juvenile brown and white shrimp, red drum, gag grouper, scamp, red, gray, and lane snapper, greater amberjack, king and Spanish mackerel, cobia, and Gulf stone crab occur in the SNWW study area and may include estuarine emergent wetlands, estuarine mud, sand, and sand and shell substrates, SAV, estuarine and offshore water column. Shell substrate in the project area would be dredged with the Preferred Alternative. Open-bay bottom habitat would be impacted by the Preferred Alternative relative to the No-Action Alternative. In addition, Sabine Lake and the GIWW/Lake Charles Deepwater Channel would be impacted in one-time contracts to remove sediment for Willow and Black bayous mitigation measures, causing temporary increases in water column turbidity and removal of benthic fauna.

Initial placement operations would cover benthic organisms with dredged material in the ODMDS sites. Recovery of some benthic organisms would likely occur relatively quickly, although the assemblage in the dredged material might differ from the assemblage that existed at the PA prior to construction. Sheridan (1999) found that recovery of the benthic community would continue for at least 18 months for some parameters and beyond 3 years for others.

With the Preferred Alternative, increased water column turbidity during dredging would be localized and temporary. Teeter et al. (2003) found that the area of high turbidity extended roughly to the edge of the fluid mud flow, or about 1,300 to 1,650 feet from the discharge pipe. Modeling of dredged material discharge in the Laguna Madre determined that turbidity caused by dredging only lasts on the order of weeks to a few months, and therefore impacts to the estuarine and offshore water column would be minimal (Teeter et al., 2003). Material to be dredged is not contaminated and should not pose contamination issues with respect to EFH. Accidental spills have the potential to impact EFH, and larval and juvenile finfish could be affected significantly should a spill occur. Larval and juvenile finfish tend to be more susceptible to spills than adults and could be affected extensively by a spill during their active immigration periods. Due to their lack of mobility, they are less likely to be able to avoid these areas and could be negatively impacted if a spill were to occur; however, there would be no increase in spill chances because of the larger channel and the fewer vessel trips that are predicted with the Preferred Alternative versus the No-Action Alternative.

The Preferred Alternative would temporarily and locally impact EFH species by turbidity; however, these impacts would be minimal since these species are motile enough to avoid areas of high turbidity. Benthos, as a food source, would be lost at the ODMDS sites until recovery occurs; however, these areas are small relative to the benthic habitat near Sabine Pass and any impacts would be negligible. Restored marsh and improved shallow-water habitat in the proposed mitigation and Neches River BU Feature total 13,053 acres of EFH creation, with 43 percent (5,636 acres) being emergent marsh. Approximately 1,828 acres of open water would be improved as EFH habitat by creating smaller, shallow-water pools and channels in which fetch and turbidity are reduced. In addition, another 5,589 acres of existing marsh within the influence areas targeted for mitigation measures and BU would be nourished by the winnowing of fine-grained sediments during unconfined placement of the dredged material.

The DEIS initiated EFH consultation under the MSFCMA. NMFS provided concurrence with the findings on March 8, 2010 (Appendix A3).

4.11.2.4 Ballast Water

4.11.2.4.1 No-Action Alternative

Under the No-Action Alternative, ship traffic in the SNWW would increase at rates predicted by the economic analysis.

4.11.2.4.2 Preferred Alternative

Although ship traffic would increase with the Preferred Alternative, the FWP increase would be less than the predicted growth of ship traffic under the No-Action Alternative, and therefore no additional impacts with respect to ballast water are expected. The economic analysis has determined that the maximum size of vessels using the deepened channel is not expected to increase; rather, vessels would be loaded to deeper drafts to take advantage of the increased depth. Therefore, an increase in the volume of ballast water is not expected. Furthermore, no changes in foreign ports of call are predicted.

4.11.2.5 Recreational and Commercial Fisheries

4.11.2.5.1 No-Action Alternative

Under the No-Action Alternative, recreational and commercial fisheries would continue as described in subection 3.10.2.4. Additional discussion of impacts associated with normal maintenance dredging activities is discussed in subsection 4.11.2.5.2.

4.11.2.5.2 Preferred Alternative

Temporary and minor adverse effects from the proposed project and mitigation measures on recreational and commercial fisheries may result from altering or removing productive fishing grounds and interfering with fishing activity. Sheridan (1999) found that sheepshead, spotted seatrout, brown shrimp, pink shrimp (*Litopenaeus duorarum*), white shrimp, and blue crab numbers increased as SAV coverage improved following dredging, with few species collected at the site of the disturbance. Only spot (*Leiostomus xanthurus*), Atlantic croaker, and southern flounder were somewhat more numerous at the dredged material PA. However, the evaluation of effects on the estuarine habitats and fauna and Gulf habitats and fauna of the region (sections 4.10 and 4.12) concluded that no significant impacts to food sources for nekton were likely. Therefore, reductions of nekton standing crops would not be expected from the No-Action or Preferred Alternative. In particular, major species of nekton, including sciaenid fishes and penaeid shrimp, should not suffer any significant losses in standing crop. Recreational and commercial fishing would therefore not be expected to suffer from reductions in the numbers of important species from the Preferred Alternative.

Repeated dredging and placement operations may temporarily reduce the quality of recreational and commercial fisheries in the vicinity of dredging operations. This may result from decreased water quality and increased turbidity during project dredging and mitigation measures, as well as from a loss of attractiveness to game fishing resulting from loss of benthic prey. This condition is not permanent, and the quality of fishing in the vicinity of the channel and PAs should steadily improve after dredging is completed and would likely be similar to existing maintenance dredging, as under the No-Action Alternative. During project dredging and mitigation measures, game fish would leave prime recreational fishing areas for more-favorable, less-turbid locations; however, once dredging is completed, conditions would improve and game fish would return to the area. The additional habitat created by construction in the BU sites should provide additional recreational fishing opportunities. Construction activity in this portion of the channel should not significantly affect overall fishing in the general project area.

The impacts from the Preferred Alternative to both boat and wade-bank fishing would be temporary, potentially resulting in local disturbances, particularly along the edges of the channels. After dredging is completed, these areas should return to predredging conditions. A significant portion of the overall recreational fishing effort in the project area occurs in Sabine Lake and offshore; however, project dredging activities and mitigation measures should not significantly affect overall fishing.

Commercial fishing for shellfish (specifically blue crab) in Sabine Lake is very important; however, no significant long-term impacts are expected for the No-Action or Preferred Alternative.

4.12 WILDLIFE

4.12.1 No-Action Alternative

Existing dredging activities and placement of dredged material could result in sedimentation and altered hydrology, which could have a temporary, short-term, and localized impact on some species. On larger temporal scales, the No-Action Alternative would result in no immediate direct impacts to the terrestrial wildlife species or wildlife habitats at or near the proposed study area. However, the combined effects of subsidence, saltwater intrusion, and wetland loss from sea level rise would convert estuarine and coastal habitats and their wildlife communities. These habitat changes are likely to be exacerbated by the effects of global climate change. In the absence of the project and associated marsh restoration projects, the loss of freshwater marsh habitats would likely continue due to RSLR. Salinities would likely increase in estuary tributaries, causing continued conversion of freshwater to brackish marsh, in turn favoring colonization by euryhaline species. Last, a long-term reduction in freshwater inflow to the estuary (since the human population of the state is expected to double during the life of the proposed project) could also result in coastal and estuarine habitat conversion.

4.12.2 Preferred Alternative

4.12.2.1 Dredging/Construction Activities

Direct effects of the proposed project are those associated with navigation channel improvements, and the placement of dredged material. They include (1) impacts to benthic organisms and their Gulf, estuarine, and riverine water-bottom habitats resulting from dredging to construct navigation improvements, ODMDSs, borrow areas for mitigation measures, and marsh restoration in shallow, open-water areas for BU features and mitigation measures; (2) dredging impacts to bottom-feeding and pelagic organisms such as sea turtles; (3) impacts to marshes and upland habitats from the enlargement of PAs; and (4) impacts to shorebirds and their habitat from the regular placement of maintenance material on the Gulf shoreline.

While dredging activities from the proposed project are unlikely to have a direct impact on terrestrial wildlife species, they may have an indirect impact. Such activities may cause temporary, local impacts to aquatic communities and habitats, including increased turbidity, which in turn may indirectly affect birds in the immediate vicinity by potentially reducing the availability of the food supply. These impacts are local and temporary and are not likely to be significant considering the overall availability of similar habitats in the general area and the mobility of the birds. The slightly increased possibility of accidental spills of oil, chemicals, or other hazardous materials during construction dredging activities also poses a threat to the aquatic community and, thus, the food source of many coastal birds in the area. Accidental spills could adversely affect phytoplankton and zooplankton assemblages, which make up the foundation of the aquatic food chain. While adult shrimp, crabs, and fish are mobile enough to avoid areas of high concentrations of pollutants, larval and juvenile finfish and shellfish are more susceptible to those threats. Any effects would be short term.

The noise of equipment and increased human activity during dredging activities may disturb some local wildlife, particularly birds, especially during the breeding season. Such impacts, however, should be temporary and without significant long-term implications. Salinity effects are unlikely, and most infaunal organisms in the area are relatively tolerant of salinity fluctuations.

Dredging activities for the channel improvement would occur adjacent to many of the rookeries noted in subsection 3.11.2; however, it is unlikely that dredging activities would result in impacts to these rookeries since no placement would occur in the rookeries and the birds are accustomed to the noise of maintenance dredging.

Dredged material would be used beneficially for marsh creation in the Neches River BU Feature and for shore nourishment in the Gulf Shore BU Feature. Mitigation measures include marsh restoration in the Willow Bayou hydro-unit and in the Black Bayou hydro-unit. In addition, 16 existing and 2 new upland PAs would be used for construction and maintenance of the 48-foot project.

Placement of dredged material at these sites would have similar impacts to the dredging activities in that they would be unlikely to result in direct effects on terrestrial wildlife species but may have indirect effects. Temporary impacts to aquatic communities and habitat from increased sedimentation and turbidity would be expected. This in turn may affect birds and amphibians in the area by potentially reducing the availability of their local food supply temporarily. The impacts may be more noticeable if the sites are located near known bird rookeries. Noise and increased human activities during construction may temporarily affect terrestrial wildlife in areas adjacent to the restoration sites. Construction activities during the placement of material on the beach may temporarily preclude its use by wildlife; however, the duration of the activity would be temporary and the size of the construction area would not be large enough to cause any significant loss of habitat. These impacts would likely be minor and short term. The resultant additional marsh and beach restoration would provide additional habitat for wildlife in the area. Therefore, the proposed activity would not have adverse effects on terrestrial wildlife.

4.12.2.2 Operational Activities

Upon completion of the initial dredging activities associated with the project, few impacts are likely. Maintenance dredging activities would have similar temporary impacts as the initial dredging, but on a much smaller scale and for a shorter term. The number of vessels in the area would not increase or decrease; therefore, the potential for erosion of PAs would not change. The possibility of accidental oil or chemical spills would decrease because of safer navigability. Such spills pose a threat to the aquatic community and, thus, the food source of many coastal birds in the area. Impacts from noise and human activity are unlikely to be a factor.

Construction activities during the placement of dredged material at marsh creation sites and on beaches may temporarily preclude its use by wildlife; however, the duration of the activity would be temporary and the size of the construction area would not be large enough to cause any significant loss of habitat. The resultant additional marsh and beach restoration would provide additional terrestrial habitat for wildlife in the area. Therefore, the proposed activity would not have adverse effects on terrestrial wildlife.

4.13 THREATENED AND ENDANGERED SPECIES

A BA for this project has been prepared to fulfill the USACE requirements as outlined under Section 7(c) of the ESA of 1973, as amended, and is included in Appendix G1. The USACE is consulting with the NMFS and USFWS as required by Section 7(a)(2). NMFS issued a Biological Opinion (BO) on a previous similar project alternative. That opinion found that the proposed action was not likely to jeopardize the continued existence of any endangered or threatened species or result in the destruction or adverse modification of critical habitat of such species (Appendix G2). While the project alternative changed, project-related impacts remained the same, and therefore the BO conclusion would remain the same.

4.13.1 No-Action Alternative

The No-Action Alternative would result in no immediate direct impacts to any endangered wildlife species or endangered species habitat at or near the proposed study area. The potential impacts to endangered sea turtles from maintenance dredging are covered by the BO for the USACE's maintenance dredging activities in the Gulf (NOAA, 2003), and therefore are not addressed in this FEIS.

4.13.2 Preferred Alternative

4.13.2.1 Dredging/Construction Activities

No federally or State-listed plant species are of potential occurrence in Jefferson or Orange counties, Texas, or Cameron or Calcasieu parishes, Louisiana (NDD, 2005a, 2005b, TPWD, 2010; USFWS, 2005c, 2009). Thus, the proposed project would not result in impacts to any threatened or endangered plant species.

The proposed project is unlikely to affect any threatened or endangered terrestrial species. Many are inland species that are not likely to occur in the affected areas, while others are migrants that pass through the region seasonally. Federally listed species likely occurring in the study area at some time of the year include the piping plover. Several threatened and endangered sea turtle species, of potential occurrence in study area waters, could be affected by project construction and maintenance activities. Potential impacts to threatened and endangered terrestrial and marine species have been assessed by the USACE in a BA presented in Appendix G1 of this FEIS.

Dredging activities, which would occur in open water, would not directly affect the wintering piping plover. The greatest potential for impacts to the wintering piping plover would be associated with the placement of dredged materials for shoreline nourishment activities in areas of suitable habitat (the Gulf Shore BU Feature). The USFWS has designated the entire shoreline between Constance Beach and Sabine Pass (Unit LA 1, in part) as critical habitat for the piping plover. Proposed beach nourishment activities at Louisiana Point would occur along approximately 3 miles of this unit, beginning approximately 0.5 mile east of Sabine Pass. Details of the Gulf Shore BU Feature beach nourishment activities are included in Section 4.2 of the BA (Appendix G1). A survey of both the Texas and Louisiana shore nourishment sites was conducted in July 2006 (see Attachment A to the BA). No habitat was found on the Texas side; the current shoreline within the proposed nourishment zone in Texas is an eroding marsh and contains no beach. In Louisiana, several areas suitable for piping plovers were identified. Large tidal sand/mudflats and sandbars located just offshore of Louisiana Point appeared to provide wintering piping plover feeding habitat. In addition, sandy beaches beginning 2 miles from the east jetty contain tidal flats with sparse vegetation suitable for feeding and roosting habitat. Placement of dredged materials (i.e., Gulf shoreline nourishment) at Texas Point and Louisiana Point would not adversely affect piping plovers or designated Critical Habitat for the wintering piping plover. These impacts of placement activities would be temporary and local in nature. Some birds could be temporarily displaced, but there is sufficient habitat nearby to accommodate them. In general, the BU feature should result in positive effects on the piping plover by increasing the extent of suitable habitat in the study area. On the Louisiana side, where some Critical Habitat exists, additional beach may allow siltation to create some microtopographic relief on the backbeach, providing another primary constituent element for the Critical Habitat. Based on the facts listed above, the proposed project may affect but is not likely to adversely affect the piping plover or its Critical Habitat.

Loggerhead, Kemp's ridley, hawksbill, leatherback, and green sea turtles may be present in study area waters during certain times of the year. Thus, construction and postconstruction maintenance activities could result in impacts to the sea turtles, should they be present in the project area. A pipeline dredge would be used in those reaches of the SNWW inland of the Jetty Channel, and a hopper dredge would be used in the Sabine Pass Jetty Channel, the Sabine Pass Outer Bar Channel, the Sabine Bank Channel, and the Extension Channel. Sea turtles easily avoid pipeline dredges because of the slow movement of the dredge. The potential for incidental take of sea turtles by hopper dredges would be minimized by the use of draghead deflectors. Since new work dredging would require continuous hopper dredging for approximately 6 years, a winter dredging window for construction cannot be accommodated. Maintenance dredging has been conducted during all seasons between 1996 and 2005. Relocation trawling has been used since 2002, when maintenance dredging in the Sabine Bank Channel resulted in the lethal take of two sea turtles (Rob Hauch, pers. communication, 2006). In 2006, maintenance dredging in the Sabine Bank Channel resulted in the lethal take of one Kemp's ridley sea turtle (USACE, 2006c). Apart from direct mortality, dredging activities could have an impact on sea turtles through an increase in sedimentation and turbidity. There have been no reports of sea turtles nesting in the study area. Feeding opportunities within the proposed channel could attract sea turtles, where they might be exposed to additional risks from boat traffic, contaminants, fishing activities, tangled fishing lines, and accumulated plastic detritus, but that is true at the existing channel.

The effects on sea turtles of placing dredged material at the proposed ODMDSs include (1) a collision potential from the vessel; (2) the deposition of dredged material on turtles and forage areas; and (3) the possibility of trash and debris from the dredge operation. Regarding the deposition of dredged material, modeling indicates that most of the dredged material is confined to a relatively small area. Because this is a short-term effect, and considering the mobility of the turtle species and the lack of limestone ledges in the proposed ODMDSs, the sea turtles should easily be able to avoid a descending plume and available food sources should not be seriously reduced (NMFS, 2003). Regarding the vessel and debris possibility, it is the combined effect of many marine activities (e.g., oil spills, oil and gas operations, commercial fishing, marine transportation, etc.) that constitute the hazard and not a single activity such as a dredge operation. These activities, combined with natural predation and development on land, result in a cumulative adverse effect on sea turtles (Rosman, 1987). The Outer Bar Channel would be deepened at the existing width of 800 feet, and the width would quickly taper to 700 feet in the Sabine Bank Channel.

The dredging operation in the existing offshore channels is similar to, but of longer duration than, routine maintenance dredging. The Entrance Channel Extension would begin 18 miles offshore where sea turtles should be more dispersed than nearer the jetties. Only three lethal takes have been observed during maintenance dredging between 1996 and 2006, a period that entailed water temperatures ranging from 49.0 to 89.6°F. Based on the facts listed above, the proposed project may affect and is likely to adversely affect sea turtles. No critical habitat for sea turtles is present within the study area; therefore, the project is unlikely to adversely affect critical habitat.

4.13.2.2 Operational Activities

Upon completion of the initial dredging activities associated with the project, few impacts to endangered species or critical habitats are likely. Maintenance dredging activities would have similar temporary impacts as the initial dredging for recurring but shorter terms. The probability of accidental oil or chemical spills would decrease because there would be fewer vessel trips. Such spills pose a threat to the aquatic community and, thus, the food source for the piping plover. Impacts from noise and human activity are unlikely to be a factor. Maintenance dredging activities for the proposed project are covered by an existing agreement between the NMFS and USACE regarding the taking of sea turtles with hopper dredges, to ensure that significant impacts do not occur (NOAA, 2003).

4.13.2.3 USFWS Coordination and NMFS Biological Opinion

4.13.2.3.1 Piping Plover, Brown Pelican, and Bald Eagle

Placement of dredged materials (i.e., Gulf shoreline nourishment) at Texas Point and Louisiana Point would not adversely affect wintering populations of piping plovers or designated Critical Habitat for the piping plover. These activities should result in positive effects on the piping plover by increasing the extent of suitable habitat in the study area. On the Louisiana side, where Critical Habitat is designated, additional beach may allow siltation to create some microtopographic relief on the backbeach, providing another primary constituent element of the piping plover Critical Habitat. Based on the information listed above and presented in detail in the BA (Appendix G1), the Preferred Alternative is not likely to adversely affect the piping plover or its Critical Habitat.

The current Preferred Alternative eliminates proposed widening from the Sabine Pass Jetty Channel through the Port Arthur Canal, removes proposed beneficial use of dredged material at Bessie Heights West, and modifies the size and configuration of the Rose City BU feature. However, all other project features remain the same, and effects to threatened and endangered species and Critical Habitat have not changed. The USFWS, in letters dated March 20 and March 22, 2007 (Appendix A2), concurred that the deepening and widening 48-foot alternative was not likely to adversely affect the piping plover or its Critical Habitat. The USFWS Louisiana Field Office stated that no further ESA consultation would be required with its office unless changes are made to the scope or location of the project. Changes to the Preferred Alternative have not affected project impacts; therefore, no change is anticipated to the USFWS's "no effect" determination. The USFWS Clear Lake Field Office letter was silent on the need for further consultation. However, the USACE staff confirmed by telephone that no further ESA consultation would be required unless changes are made to the scope or location of the project. The Clear Lake Field Office did recommend that steps be taken to determine whether bald eagles are nesting within or near the project area since the number of bald eagles in Texas is increasing. Prior to project construction, the USACE will check with the TPWD and local landowners to determine whether there have been recent bald eagle sightings and determine the need for surveys at that time.

The USFWS provided further guidance in a letter dated February 5, 2010, and recommended that all activity in Louisiana occurring within 2,000 feet of a brown pelican rookery be restricted to the non-nesting period (i.e., September 15 through March 31). However, because nesting periods vary considerably among Louisiana's colonies, it is possible that this activity window could be altered based upon the dynamics of the individual colony. Prior to project construction, the LDWF Fur and Refuge Division will be contacted to obtain the most current information about the nesting chronology of individual brown pelican colonies. In Texas, the USFWS recommended all activity occurring within 1,000 feet of a rookery be restricted to the non-nesting season.

4.13.2.3.2 Sea Turtles

Based on the facts listed above and presented in detail in the BA (Appendix G1), the Preferred Alternative may affect and is likely to adversely affect sea turtles. No Critical Habitat for sea turtles is present within the study area; therefore, the Preferred Alternative would not affect sea turtle Critical Habitat.

A BO, prepared by the NMFS for the previous 48-foot deepening and widening alternative, is presented in Appendix G2. The BO (dated August 13, 2007) concluded that the action, as proposed, was likely to adversely affect but is not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, hawksbill, leatherback, or green sea turtles. The effects of the current Preferred Alternative on sea turtles are the same as those previously coordinated, and it is not anticipated that this determination would change. Although some short-term reduction in numbers and reproduction is expected, the anticipated take of sea turtles would not appreciably increase the risk of extinction of these species in the wild. The BO authorizes incidental lethal take of four turtles (three Kemp's ridley and one loggerhead or green sea turtle) during the course of the proposed project's hopper dredging. This estimate is based on the implementation of relocation trawling to prevent additional lethal takes by hopper dredges. Further, this opinion authorizes the per-fiscal-year non-lethal, non-injurious take (minor skin abrasions resulting from trawl capture are considered non-injurious), external flipper-tagging, and taking of tissue samples of 32 sea turtles in any combination, though 7 loggerhead, 21 Kemp's ridley, 1 hawksbill, 1 leatherback, and 2 green sea turtles would be expected in association with any relocation trawling conducted during the course of the proposed project.

NMFS determined that the following reasonable and prudent measures are necessary and appropriate to minimize impacts of the incidental take of sea turtles during the proposed action. Only incidental takes that occur while the following measures are in full implementation are authorized. For brevity, the reasonable and prudent measures are only summarized below. The reader is referred to the BO in Appendix G of this FEIS for the detailed measures, terms, and conditions.

Reasonable and Prudent Measures:

1. **Temperature- and date-based dredging windows**:
   - Hopper dredging activities shall be completed, whenever possible, between December 1 and March 31, when sea turtle abundance is lowest throughout Gulf coastal waters.
   - Pipeline or hydraulic dredges, because they are not known to take turtles, must be used whenever possible between April 1 and November 30.
2. **Observer Requirements**: The USACE shall arrange for the NMFS-approved protected species observers to be aboard the hopper dredges to provide 100 percent monitoring of the hopper bin, screening, and dragheads for sea turtles and their remains between April 1 and November 30, and whenever surface temperature are 52°F or below.
3. **Deflector Dragheads**: A state-of-the-art rigid deflector draghead must be used on all hopper dredges at all times.
4. **Relocation Trawling**: Relocation trawling is required after the take of one sea turtle during the project. In general, it is also recommended as a useful conservation tool. The BO authorizes the per-fiscal-year nonlethal noninjurious take, external flipper-tagging, and taking of tissue samples of 32 sea turtles in any combination, though anticipates 7 loggerhead, 21 Kemp's ridley, 1 hawksbill, 1 leatherback, and 2 green sea turtles in association with any relocation trawling conducted during hopper dredging.

4.14 CULTURAL RESOURCES

4.14.1 No-Action Alternative

Under the No-Action Alternative, archeological sites around the margins of eroding marsh areas would increasingly be exposed to the erosive effects of wind, tidal action, and RSLR as marshes convert to water, increasing fetch and erosive potential. Archeological sites along the SNWW navigation channel would continue to be exposed to the erosive forces of boat wakes; this would increase in the future as vessel trips rise to support projected imports under the current lightering requirements. Maintenance dredging of the SNWW would continue, with the potential to affect unidentified shipwrecks in or alongside the existing channel.

4.14.2 Preferred Alternative

The proposed CIP would not affect the two properties listed in the NRHP that are located near the project area (the Sabine Pass Lighthouse and the Rainbow Bridge) or the SAL, the USS *Clifton*, nor would it affect the submerged, offshore Sabine River Valley. Although the existing channel and ODMDSs cross the center of the submerged valley, the footprint of the deeper channel and existing ODMDSs would not be enlarged. The channel extension and new ODMDSs are located south of the valley. The Sabine Pass Lighthouse, which is listed in the NRHP, is located in an area that would not be affected by channel improvements to the SNWW. Use of the nearby PA 5 would not limit or remove access to the lighthouse.

All areas that would be impacted by the SNWW CIP have not been assessed for their potential to contain properties eligible for the NRHP in accordance with the National Historic Preservation Act (NHPA). Therefore, the SNWW CIP has the potential to adversely affect eligible historic properties. The USACE has negotiated a Historic Properties Programmatic Agreement (HPPA) under 36 CFR 800.14(b) to govern subsequent investigations, to coordinate surveys of impact areas, to test potentially eligible sites (Table 4.14-1), and to manage data recovery or avoidance measures as necessary. A copy of the signed HPPA is provided in Appendix H of this FEIS.

Table 4.14-1
Terrestrial and Marine Historic Properties Potentially Adversely Affected by the SNWW CIP

Resource	Location	Eligibility
Marine		
TB8.1	Neches River Channel	Potentially Eligible
IS4.2	Neches River Channel	Potentially Eligible
IS4.10s	Neches River Channel	Potentially Eligible
TB4.1	Neches River Channel	Potentially Eligible
TB4.2	Neches River Channel	Potentially Eligible
TB4.3s	Neches River Channel	Potentially Eligible
IS4.6	Neches River Channel	Potentially Eligible
IS4.12s	Neches River Channel	Potentially Eligible
IS4.11s	Neches River Channel	Potentially Eligible
IS4.8	Neches River Channel	Potentially Eligible
IS4.9s	Neches River Channel	Potentially Eligible
IS3.1	Sabine-Neches Canal	Potentially Eligible
IS2.1	Port Arthur Canal	Potentially Eligible
IS2.14s	Port Arthur Canal	Potentially Eligible
Terrestrial		
41JF29	Neches River	Potentially Eligible
41JF43	Neches River	Potentially Eligible
41OR10	Neches River	Potentially Eligible
41OR11	Neches River	Potentially Eligible
16CM26	Near LA 2-19B Mitigation Area	Potentially Eligible
16CM86	Within LA 3-10R Mitigation Area	Potentially Eligible
16CM103	Near LA 2-18B Mitigation Area	Potentially Eligible

Additional investigations are anticipated at this time, including survey of the proposed channel extension, areas affected by construction of the DMMP BU features, and areas affected by the construction of mitigation measures. No surveys are recommended for new or existing ODMDSs as placement activities are not expected to adversely impact unrecorded wrecks that may be present, given the depth of water through which the material would settle, the expected depth of burial at the time of placement, and the dispersive nature of the seabed environment in this portion of the Gulf. Impacts to archeological sites in and around the margins of degraded marsh areas proposed as DMMP BU features or as mitigation measures would be avoided to the greatest extent possible. The restoration of currently eroding marsh areas would prevent the further erosion of sites by stabilizing landforms and creating protective marsh buffers.

Costs for additional terrestrial archeological survey and testing, and nautical archeological survey and dive assessments are included in the Engineering and Design cost of the project estimate. Funds for potential archeological data recovery are also included in the project cost estimate as a full Federal cost per Section 7 of PL 93-291. While no specific historic property impacts have been identified at this time, there is a high potential to affect a significant historic shipwreck. The highest potential for historic property data recovery is associated with channel deepening through Sabine Pass, the site of a significant Civil War naval battle. To cover estimated costs for historic property data recovery, funds have been included in the project cost estimate for potential data recovery projects during the construction phase.

4.15 SOCIOECONOMIC RESOURCES

4.15.1 No-Action Alternative

Under the No-Action Alternative, the study area would continue on its present course of economic development, population growth trends, and residential and industrial development patterns. The demand for community facilities, services, and housing would not increase within the study area since there is low projected population growth. The locations of these resources would generally follow development and land use plans identified by surrounding cities and Hardin, Jefferson, and Orange counties and Cameron and Calcasieu parishes. Because no property is likely to be removed from the tax rolls, the tax base would not be affected. The No-Action Alternative could possibly have a negative effect on the local economy within the study area. Transportation costs and operational inefficiencies with the existing ship channel could possibly change industry trends, thereby changing the number of employed persons.

Under the No-Action Alternative, the counties of Hardin, Jefferson, and Orange in Texas, and Cameron and Calcasieu parishes in Louisiana areas of the proposed project would continue to have slow to moderate population growth and moderately low commercial, residential, and industrial land development (see Section 3.14). The channel areas starting at the Port of Beaumont and continuing to the Gulf would continue to function as a leader in industrial facilities and international commerce in the study area. The ports would also continue to develop their industrial properties but at a slower rate than with the Proposed Alternative. Without the channel deepening, higher transportation costs and operational inefficiencies related to large vessels would continue. As a result, future growth at the ports would likely be slower and less than if the SNWW were improved.

4.15.2 Preferred Alternative

4.15.2.1 Population and Social Characteristics (Demographics)

The Preferred Alternative would not likely have an effect on population growth trends within the study area. Population in this area is projected to grow at a low rate. As a result of the Preferred Alternative, demand for community facilities, services, and housing would not increase in the study area. The location of these resources would generally follow development and land use plans currently identified. Most of the construction workers are likely to come from the labor force that is already living within Hardin, Jefferson, and Orange counties, in Texas, and Cameron and Calcasieu parishes in Louisiana; therefore, immigration to the study area would be small. Over 72 percent of housing within the study area is occupied. Thus it is unlikely there would be an increase in single-family home construction. The projected population growth trend over 60 years for the study area has very little or no increase. Population growth for this area is not expected to change much from present. This alternative would have a minimal effect on the demographics of the study area.

4.15.2.2 Environmental Justice

The population living within the study area is primarily comprised of white persons (59.6 percent), followed by black or African American persons (26.7 percent), and Hispanic or Latino persons (9.6 percent); therefore, the proposed project would not be located within a minority area. Jefferson County consists of the highest minority populations of both African Americans (33.4 percent) and of Hispanic Origin (10.6 percent). In Jefferson County, census tracts 51 and 61 consist of the two highest populations of African American persons at 93.5 and 93.3 percent, respectively. Census tracts 101 and 56 in Jefferson County consist of the highest percentages of Hispanic persons at 45.3 and 41.4 percent, respectively. Both census tracts 51 and 61 in Jefferson County would be considered minority areas. The average median household income for the study area census tracts was $28,884, which is above the Department of Health and Human Services (HHS) 2006 poverty guideline of $20,000 for a family of four (HHS, 2006). The percent of persons living below poverty for the study area was 18.5 percent, which is higher than the State of Texas (15.0 percent), but is not more than 10 percent higher than the percent living below poverty for the Texas counties of Hardin (11.1 percent), Jefferson (16.3 percent), and Orange (13.6 percent), and Cameron Parish (12.2 percent) and Calcasieu Parish (15.0 percent) in Louisiana; therefore, the study area is not considered a low-income area.

The minority and low-income populations living within the study area would likely experience no adverse changes to the demographic, economic, or community cohesion characteristics within their respective neighborhoods as a result of the proposed project. Generally speaking, the populations living within the study area would not likely see any change from the proposed project. Therefore, the Preferred Alternative would not result in disproportionately high and adverse impacts on minority and low-income persons living within the study area.

4.15.2.3 Community Values

The Preferred Alternative would neither divide nor isolate any particular neighborhood nor separate residents from community facilities. It would likely have a negligible effect on population growth trends within the study area, and residential, commercial, and industrial development would likely continue at the same rate. Population in this area is projected to continue with its low growth rate, regardless of the proposed project, and demand for community facilities, services, and housing would continue at a rate that is consistent with the projected population growth. The location of these resources would generally follow development and land use plans identified by local jurisdictions. Therefore, the proposed project would not result in a negative impact to community values.

4.15.2.4 Housing

The Preferred Alternative is not expected to result in a substantial increase in population within the study area. In Calcasieu Parish, 10 percent of total housing is vacant, while in Cameron Parish there is 33 percent vacant housing. Hardin County consists of 10.2 percent vacant housing. Jefferson and Orange counties both have 9 percent vacant housing. Population growth is not expected to increase in the area; therefore, available housing would not affect the proposed project.

4.15.2.5 Economic Characteristics of Area Population

With the Preferred Alternative, as with the No-Action Alternative, the study area would continue to have large industrial facilities of the Neches Channel such as Trinity Industries, ExxonMobile, Mobile Chemical, and North Star Steel located near the Port of Beaumont. Other industries such as Huntsman, Ameripol Synpol/Huntsman, Motiva Enterprises, Air Liquide, and Entergy-Sabine Plant are located just north of Port Neches. The Preferred Alternative would not result in negative impacts to the local economy.

4.15.2.6 Leading Economic Sectors

The “industrial mix” in the study area of manufacturing, port-related, construction, transportation, and public utilities is typically reliant on contract labor. When a project is completed, companies would lay off their workforce until the next contract is awarded. In terms of competition for workers, the port-related, manufacturing, and industrial-related employers of the study area do not have to compete much with other industries because of the higher wages these employers offer over the services, retail, and wholesale trade and government services. Another factor affecting employment among manufacturing and port-related employers is the increased reliance on mechanized means of production. This type of production has a relatively small increase in the number of employees. During project construction, the study area may have a slight increase in construction employment and local purchases of construction materials but would be temporary, if any change at all.

4.15.2.7 Labor Force and Employment

The increase in jobs, economic output, and the tax base would be fairly slow and consistent with historical growth trends. The ports and their associated industries and international commerce currently serve an important role for the study area economy. These industries provide jobs, income, and a tax base for the area, and the effects reverberate within other industries such as housing, retail services, and wholesale trade. The Preferred Alternative would likely promote the development of industrial sites along the ship channel in Hardin, Jefferson, and Orange counties and Cameron Parish. This goal would be consistent with a steady historical trend towards increased reliance on these industries and these types of development within the region.

As previously discussed, the primary economic bases of the study area include petrochemical processing, construction, mineral extraction, tourism, commercial fishing, and agriculture. As a result of the proposed project, the positive economic effects to the study area economy would be moderate at the least and substantial at best.

4.15.2.8 Personal Income

Within the study area census tracts, tract 16 in Jefferson County had the lowest per capita income ($11,833) and tract 223 in Orange County had the highest ($48,586). Tract 16 is located within Beaumont and would benefit very little, if any at all, from the Preferred Alternative.

4.15.2.9 Oil and Gas Production

SNWW refinery capacity presently represents 6 percent of the U.S. total; furthermore, SNWW's 2002–2006 crude petroleum waterborne imports comprised 12 percent of U.S. and 18 percent of Petroleum Administration Defense District (PADD III) imports (USACE, 2008b).

In addition to existing crude oil and petrochemical product facilities on the SNWW, one LNG facility began operation in 2008, and construction of a second facility is nearing completion; a third has received regulatory approval. It is anticipated that oil and gas production would continue to be a major employer and industry within the study area. The Preferred Alternative would provide the necessary transportation improvements that would continue to support the export of petroleum commodities as well as support predicted crude oil imports.

4.15.2.10 Public Finance

No impacts to public finance are anticipated from the Preferred Alternative.

4.15.2.11 Land Use

All proposed channel improvements for the Preferred Alternative occur in open-water locations (they would not affect any shoreline land uses). The only land use implications for the Preferred Alternative relate to upland PAs and indirect future land development, which may occur as a result of the proposed project.

Approximately 1,900 square miles of the study area includes portions of Jefferson, Hardin, and Orange counties, Texas, and Calcasieu and Cameron parishes, Louisiana. The study area includes nine municipalities: Beaumont, Port Neches, Nederland, Groves, Port Arthur, Bridge City, Vidor, Orange, and West Orange.

The greatest long-term land use consequence of the proposed project would likely be a change in future land uses that would occur in response to the improvements to the channel. These future land uses are not considered part of the proposed project but would be less likely to occur without it. When the Preferred Alternative is complete, the ports would have a deeper ship channel providing an incentive for new industrial development at all of the ports' properties, based on navigation cost savings. Future industrial development may include oil and gas refineries or upgrades, petrochemical plants or upgrades, LNG plants, and bulk grain facilities. The long-term land use effects of these industrial facilities are largely unknown; however, given recent trends in the area, they would not likely lead to a substantial increase in demand for new housing development, new roads, commercial services, schools, or other services within Hardin, Jefferson, and Orange counties in Texas or Calcasieu and Cameron parishes in Louisiana.

Proposed land uses for the Preferred Alternative were evaluated to determine if they could increase wildlife hazards to aircraft using public use airports in the study area: the Beaumont Municipal Airport, the Southeast Texas Regional Airport, and the Orange County Airport (see figures 3.14-4a–d). All three airports sell Jet-A fuel, and it was therefore assumed that a separation distance of 10,000 feet for any of the hazardous wildlife attractants would apply, in addition to the 5-mile range to protect approach, departure, and circling airspace. Certain land use practices such as waste disposal facilities, water management facilities, gold courses, agricultural cropland, and dredged material placement areas can act as attractants to wildlife that pose a strike hazard. Some natural areas such as wetlands may attract wildlife species that are associated with aircraft strikes.

Project features of the Preferred Alternatives that could serve as attractants are PAs, BU marsh restoration areas, and marsh mitigation areas. None of these project features are located within the separation perimeters for the Beaumont Municipal Airport and the Orange County Airport. None of the BU and mitigation areas are located within separation areas for any of the three airports. However, all or portions of four PAs are located between the 10,000-foot and 5-mile perimeters of the Southeast Texas Regional Airport. All of PA 23/23A and PA 21 are located between the 10,000-foot and 5-mile perimeter; PAs 18 and 24 straddle the 5-mile perimeter. All are existing designated placement areas for the SNWW navigation project. Although they are designated PAs, at times during the dredging cycle they provide habitat for birds and wildlife species that pose a strike hazard. However, no new PAs would be constructed within the separation perimeters, and no change in land use is proposed in conjunction with the Preferred Alternative.

4.15.2.12 Recreation/Tourism

Among sport-related activities, recreational fishing, wildlife watching, and hunting continue to be major parts of the outdoor recreational activities in the study area. Sabine Lake, numerous wetlands, and the Gulf are sources of recreational fishing and wildlife watching. The construction of the Preferred Alternative would have minimal negative effects on recreation within the study area, and the proposed BU and mitigation marsh restoration areas are expected to have beneficial impacts to recreational activities in the area by providing additional habitat. The Neches River BU Feature will create 2,853 acres of emergent marsh, restore 871 acres of shallow-water habitat, and nourish 1,234 acres of existing marsh. Mitigation in Louisiana’s Black Bayou and Willow Bayou watersheds would restore 2,783 acres of emergent marsh, 957 acres of shallow-water habitat, and nourish 4,355 acres of existing marsh. The Gulf Shore BU Feature at Texas Point and Louisiana Point would nourish 6.0 miles of Gulf shoreline. All of these locations would provide new habitat for native fish and wildlife species, providing more fishing and wildlife watching for this area, thus enhancing the life for recreational use.

4.15.2.13 Aesthetics

The Preferred Alternative would have a minimal effect on the overall visual quality within the study area. There would be no negative effect to the appearance of the shorelines that are adjacent to the proposed channel improvements except for temporary turbidity. The study area includes a variety of land uses, including residential neighborhoods, commercial or CBD, transportation systems (highways and railways), civic uses, parks, schools, port facilities, and heavy industrial areas. Some regions in the study area already show moderated human development. Generally speaking, the study area is not particularly distinguished in aesthetic quality from other adjacent areas within the region. The landscape exhibits a generally moderate to high level of impact from human development and alteration. The study area is not considered scenic as defined by Federal regulations by view or by roadway.

4.16 CUMULATIVE IMPACTS

4.16.1 Introduction

The President's Council on Environmental Quality (CEQ) defines cumulative impacts as those impacts "*on the environment which result from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions.*" Cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. Impacts include both direct effects (caused by an action, occurring at the same time and place as the action) and indirect effects (caused by the action, but removed in distance or later in time, and reasonably foreseeable). Ecological effects are those on natural resources and on the components, structures, and functioning of affected ecosystems, whether direct, indirect, or cumulative.

4.16.2 Method and Evaluation Criteria

The SNWW CIP FEIS follows a traditional cumulative assessment method as typically addressed under NEPA. To define the evaluation criteria and provide additional resource input to the USACE, SNND, and other project staff, an ICT comprised of resource agency representatives was established. The ICT, USACE, and SNND defined the cumulative impacts study area and evaluation criteria considered in this cumulative impacts assessment. This assessment is limited to the SNWW project area for the Preferred Alternative as defined in the Affected Environment section.

The ICT defined criteria and a project list of key past, present, and reasonably foreseeable actions. Criteria used to select projects identified as "reasonably foreseeable" for the purpose of this cumulative assessment are as follows:

a) a Congressionally mandated study or project authorized by and specifically included in a Water Resources Development Act within the last 20 years, for which there is a readily available report that documents environmental consequences, or;

b) a current or recently initiated Federal study for which there is a readily available report that documents environmental consequences, or;

c) a specific proposed or permitted, private (non-Federal, non-State, non-local government) Section 404 action or any aggregate of individual private Section 404 actions where the private action or actions required an environmental assessment (EA) or EIS for authorization and for which there is a readily available report that documents environmental consequences of the action or actions(s), or;

d) an existing or updated regional water plan or reservoir operating plan specifically related to the project area.

Projects that qualified as past, present, or reasonably foreseeable include several LNG and pipeline projects, regional water planning efforts, maintenance and operating plans and projects, habitat restoration and protection activities, and port improvements from the Gulf to the Port of Beaumont, along the SNWW. Project impacts are determined from the best publicly available information in existing documents. Not all projects are included in the impacts summary table and/or resource impact discussions because publicly available environmental documentation is insufficient to quantify and compare impacts; however, these project-specific influences may in time have additive impacts or benefits to resources in the area.

Using the above-defined criteria, the ICT defined the following projects as relevant past or present actions or existing conditions:

- SNWW 40-foot Project (maintenance dredging);
- GIWW –Texas Section, Main Channel and Tributaries, Maintenance Dredging;
- GIWW – Louisiana Section, Sabine Lake to Lake Charles;
- Neches River Saltwater Barrier Operating Plan;
- Toledo Bend Reservoir Operating Plan;
- Beneficial Uses of Dredged Material for Marsh Preservation, GIWW Port Arthur to High Island, Texas;
- Salt Bayou – McFaddin Ranch Wetlands Salt Water Control Project;
- SNWW Marine Organism Access between PA No. 11 and Sabine Lake, Texas;
- Several CWPPRA habitat protection and restoration projects;
- Sabine Pass LNG and Pipeline;
- Golden Pass LNG and Pipeline;
- Kinder Morgan Louisiana Pipeline; and
- Jefferson County Drainage District No. 6 (Diversion Channel from South Fork of Taylor Bayou, south to the GIWW).

Additionally, the ICT defined the following projects as reasonably foreseeable future actions:

- Port Arthur LNG and Pipeline;
- East Texas Regional Water (ETRW) Plan (as part of the approved Texas 2007 State Water Plan);
- Port of Beaumont Intermodal Improvements Projects, Northside and Southside;
- Keith Lake Section 1135 CAP;
- Sabine Pass to Galveston Bay Shoreline Erosion Feasibility Study; and
- Toledo Bend Reservoir relicensing.

Ongoing regional activities, initiatives, and programs may also affect local and regional drainage, navigation, flood control, and erosion control in the SNWW project area, but these actions/programs occur outside of the study area and/or effects are not project-related and cannot be quantified in this document. Programs under which such activities and initiatives may occur include the following:

- the GLO's Coastal Management Program (CMP), including "Coastal Texas 2020" (a long-term, statewide initiative to promote Texas coastal environmental and economic health);
- Louisiana's CMP;
- the USACE Galveston District navigation, flood control, and hurricane-flood protection programs, and regulatory efforts to protect wetlands and navigation channels;
- Jefferson County Drainage Districts (other than No. 6); and
- the Trinity Bay Conservation District.

Resource evaluation criteria include biological, ecological, physical, chemical, cultural, and socioeconomic resources for projects within the SNWW study area. The following resource parameters are addressed:

Physical Environment	Biological Attributes	Socioeconomic Attributes
Air Quality and Noise	Wetlands	Recreational Facilities/Areas
Topography and Bathymetry	Bottomland Habitat	Commercial/Recreational Fisheries
Soils	Terrestrial Vegetation	Ship Accidents/Spills
Sediment Quality	Submerged Aquatic Vegetation	Oil/Gas Production on Submerged Lands
Water Quality	Plankton/Benthos	Cultural Resources
Nutrients	Finfish/Shellfish	Public Health
Salinity	Mammals	Safety
Turbidity	Reptiles/Amphibians	Land Use
Contaminants	Threatened and Endangered Sp.	
Freshwater Inflow	Essential Fish Habitat	
Circulation/Residence	Migratory Birds	
Tidal Influence		

All impacts in the above categories that can be quantified from existing documents are displayed in Table 4.16-1. If an impact cannot be quantified, a qualification sourced from available documents (i.e., "benefit," "net benefit," No Impact, or Not Applicable) is presented in most instances for comparison. Project descriptions and cumulative impact assessment results follow.

Table 4.16-1

Impact Summary for Past, Present, and Reasonably Foreseeable Projects with Publicly Available Information

	Past and Present Actions[1]										**Reasonably Foreseeable Actions[1]**	
	Existing SNWW 40-foot Channel	**Neches River Saltwater Barrier**	**Salt Bayou/ McFaddin Ranch**	**SNWW Marine Organism Access**	**Beneficial Uses: Port Arthur – High Island**	**Sabine Pass LNG and Pipeline**	**Golden Pass LNG and Pipeline**	**Kinder Morgan Louisiana Pipeline**	**Habitat Restoration Projects**	**Taylor Bayou Flood Reduction**	**Port Arthur LNG and Pipeline**	**Proposed SNWW CIP**
Physical Environment												
Air Quality	NA	NI	UN	UN	NI	NO_x and CO emissions	NI[2]	NO_x and VOC emissions	NA	NI	NI[2]	NO_x emissions; anticipate SIP conformance
Noise	NI	NI	UN	UN	NI	NI	NI[2]	UN	NA	UN	NI	NI
Topography, Bathymetry, Soils, Sediment Quality	NI	Net Benefit	NA	NI[2]	Net Benefit	NI[2]	2.8 ac prime farmland; other impact NI[2]	NI[2]	Benefit emergent marsh acres created	51,000 ac removed from 100 year floodplain	1 ac prime farmland loss; other impact NI[2]	NI[2]
Water Quality	NI	Net Benefit	Benefit	NI[2]	NI[2]	NI[2]	NI[2]	NI[2]	Benefit	NI	NI[2]	Net Benefit
Freshwater Inflow	NI	Net Benefit	NA	UN	NA	NI	UN	NA	NA	NI	UN	NA
Circulation, Tides, Salinity	I	UN	NA	Benefit	Benefit	NI	UN	NA	Benefit	NA	UN	Increased salinity, NI[2]
Biological Attributes												
Wetlands (permanent loss)	I	48.4 ac	NA	NI	NI	79 ac[3]	173 ac	0.8 acres	NA	629 ac of jurisdictional waters directly impacted	679 ac	86 ac offset by DMMP; 691 ac NI[2]
Wetlands (mitigation) and DMMP restoration	NA	5 ac (plug) + 8.5 ac (in fee)	NA	NA	NA	135 ac[3]	500 ac	2.53 acres	Restored 3,695 acres emergent marsh	246 ac preserved; 44 ac created	583 ac	Mitigation-restores 2,783 ac emergent marsh, nourishes 4,355 ac existing marsh; DMMP creates 2,853 ac emergent marsh
Terrestrial Vegetation (conversion and loss)	NI	60.4 ac	Limited Benefit	UN	NI	239 ac	205 ac	NA	NA	Preservation of 1,000+ ac	972 ac	NI[2]

Table 4.16-1

Impact Summary for Past, Present, and Reasonably Foreseeable Projects with Publicly Available Information

	Past and Present Actions[1]										**Reasonably Foreseeable Actions[1]**	
	Existing SNWW 40-foot Channel	**Neches River Saltwater Barrier**	**Salt Bayou/ McFaddin Ranch**	**SNWW Marine Organism Access**	**Beneficial Uses: Port Arthur – High Island**	**Sabine Pass LNG and Pipeline**	**Golden Pass LNG and Pipeline**	**Kinder Morgan Louisiana Pipeline**	**Habitat Restoration Projects**	**Taylor Bayou Flood Reduction**	**Port Arthur LNG and Pipeline**	**Proposed SNWW CIP**
Submerged Aquatic Vegetation	NI	NA	Benefit	UN	Net Benefit	NI[2]	UN	NA	Benefit	NA	UN	Net Benefit
Plankton and Benthos	NI	NI[2]	NA	Benefit	Net Benefit	NI	Minimal[2]	NI[2]	Benefit	UN	NI	NI[2] (net benefit)
Finfish and Shellfish	NI	NI[2]	NA	Benefit	Net Benefit	NI	NA	NI[2]	Benefit	UN	NI	NI[2] (net benefit)
Essential Fish Habitat (permanent)	NI	NA	NA	UN	NI	55 ac	6.3 ac	NI[2]	Benefit	NI	NI2	NI[2]
Essential Fish Habitat (mitigation and/or creation)	NA	NA	NA	UN	NA	28 ac	NA	NA	NA	NI	UN *mitigation plan pending*	13,053 ac restored/nourished marsh and shallow water
Wildlife Habitat	I	NI	Benefit	Benefit	NI	236.6 ac	2,007 ac	NI[2]	Benefit	8,900+ ac protected	1,497 ac	NI[2] (net benefit)
Migratory Birds	NI	Net Benefit	Benefit	UN	NA	NI	Minimal[2]	NI[2]	Benefit	UN	NI[2]	NI[2] (net benefit)
Threatened or Endangered Species	NA	NI	NI	NI	NI	NI	Determination pending	NA	NA	NI	NI	Benefit
Socioeconomic Attributes												
Land Use Change	NA	Benefit to agriculture	NA	UN	NA	341 ac	911 ac	67 ac	NA	246 ac converted to protected status; change in land use to flood control for >9,000 ac	461 ac	May induce industrial development
Economy	Benefit	Benefit	UN	UN	NA	Benefit	Benefit	Benefit	NA	Benefit	Benefit	Benefit
Recreational Facilities/Areas	NA	Net Benefit	UN	Benefit	Benefit	NI	Minimal[2] (16.1 miles)	Viewshed alteration	Benefit	UN	Minimal to recreational boating	Net Benefit

Table 4.16-1

Impact Summary for Past, Present, and Reasonably Foreseeable Projects with Publicly Available Information

	Past and Present Actions[1]										**Reasonably Foreseeable Actions**[1]	
	Existing SNWW 40-foot Channel	**Neches River Saltwater Barrier**	**Salt Bayou/ McFaddin Ranch**	**SNWW Marine Organism Access**	**Beneficial Uses: Port Arthur – High Island**	**Sabine Pass LNG and Pipeline**	**Golden Pass LNG and Pipeline**	**Kinder Morgan Louisiana Pipeline**	**Habitat Restoration Projects**	**Taylor Bayou Flood Reduction**	**Port Arthur LNG and Pipeline**	**Proposed SNWW CIP**
Commercial and Recreational Fisheries	NI	Net Benefit	NI	Benefit	Benefit	NI	NI	NI[2]	Benefit	NA	Minimal	Net Benefit
Ship Accidents/Spills	UN	NA	NA	NA	NA	NI[2]	NI[2]	Potential	NA	NA	NI[2]	Net benefit *probability will decline*
Oil/Gas Production on Submerged Lands	NA	NA	NA	NA	NA	UN	UN	NI[2]	NA	NA	UN	NA
Public Health & Safety	NA	Net Benefit	NA	NI	NI	NI[2]	NI	NI[2]	NI	Benefit	NI[2]	NI[2]
Cultural Resources	NI[2]	NI	NI	NI	NI	NI	Determina-tion pending	NI	NI	NI	UN	I[2]

Benefit or Net Benefit = Results which have an overall positive effect when compared to the FWOP (baseline, existing) conditions of the resource.

NI = no long-term impacts; NA = not available; UN = unavailable; I = impact.

[1] Although not included in the table, several other projects are included in Section 4.16 Cumulative Impacts.

[2] Offset by engineering design, mitigation, data recovery, adaptive management plans/activities based on monitoring, procedures, and project controls.

[3] Includes acreage from permit amendment applications.

4.16.3 Past or Present Actions

Petroleum-related industries, most prominently refining and crude oil terminal operations, dominate the area. These and other shipping-dependent industries, alongside commercial and recreational fisheries, agricultural production, and recreation and conservation areas (NWRs, State Parks, State Historic Sites, and WMAs), have influenced this area's land use history, navigation channel development and maintenance, coastal transportation trends, and regional economic and ecological importance to both Texas and Louisiana. The discussion of baseline conditions discussed in Section 3 of this FEIS presents conditions in the study area resulting from these past actions. Past projects considered in this cumulative impacts analysis include the current SNWW 40-foot Project maintenance and other related activities, which may influence or be influenced by natural and socioeconomic resources of the area.

4.16.3.1 Sabine-Neches Waterway 40-foot Channel (past and current condition)

Two of three major area seaports are included in the SNWW project area: Port Arthur and Beaumont. The Ports of Port Arthur and Beaumont rely on a series of artificially widened and/or deepened channels that were dredged from offshore in the Gulf, through Sabine Pass, around the western shore of Sabine Lake, and up the Neches River. Channel and port improvements began in 1885 when Army Engineers completed construction of the east and west jetties (Alperin, 1977). When the jetties produced a channel depth of 25 feet through Sabine Pass, the Kansas City, Pittsburg, and Gulf Railroad and the Port Arthur Channel and Dock Company dredged a 25-foot-deep by 75-foot-wide channel from Sabine Pass to Port Arthur in 1897. Located near the seminal 1901 Spindletop oil discovery, the cities of Beaumont and Port Arthur underwent rapid and substantial growth to accommodate the new petroleum industry. The Port Arthur International Public Port was established in 1899, and a 9-foot-deep canal was dug in the Neches River from the Port Arthur Ship Channel to Beaumont in 1908. The channel was deepened to 25 feet in 1916, and a turning basin was dredged in a bend of the Neches River. By this time, dock facilities had been developed along the Neches River waterfront, creating an inland port for the City of Beaumont. Beaumont's status as a shipping center was heightened in 1922 when the channel was deepened to 30 feet. In the 1940s, the channel was deepened to 36 feet and finally to 40 feet in the 1960s (Alperin, 1977). In 1912, a 25-foot navigation channel was constructed from the mouth of the Neches River, across the northern edge of Sabine Lake, and up the Sabine River to near the city of Orange, Texas. Called the Sabine River Channel, it was deepened to 30 feet in 1922 and remains that depth today. These deep-draft navigation channels are collectively known as the Sabine-Neches Waterway.

The shallow-draft GIWW coincides with portions of the SNWW in the study area. Construction of the GIWW between the Sabine River and Galveston Bay began in 1925. Originally 9 feet deep by 100 feet wide, it was later enlarged to its current dimensions of 12 feet by 125 feet. The segment of the GIWW from the Sabine River eastward 25 miles to the Calcasieu River in Lake Charles, Louisiana, was deepened to 30 feet by local interests and authorized as a Federal project in 1935 (USACE, 1998c). It provided a deepwater navigation channel to the Port of Lake Charles through the SNWW until the 30-foot depth was abandoned upon completion of the deep-draft Channel to Calcasieu in 1941; it is presently maintained at authorized GIWW dimensions of 12 feet by 125 feet.

The existing 40-foot SNWW project is a federally authorized and maintained waterway approximately 77 miles long, located in Jefferson and Orange counties, Texas, and Cameron and Calcasieu parishes, Louisiana. Currently, SNWW maintenance dredged material, approximately 8 mcy annually, is placed in 16 upland confined PAs and 4 ODMDSs in the Gulf (see Appendix D). There was no NEPA-process document for construction of the SNWW 40-foot project, which would provide information about impacts related to construction activities; however, the operational and maintenance impacts were addressed in an EIS in 1972. The Ecological Modeling Report (Appendix C) also discusses impacts of the current condition and FWOP. From these two sources, effects for this cumulative impacts analysis include the conversion and loss of wetlands, terrestrial vegetation, SAV, and wildlife habitats from the creation of PAs and saltwater intrusion. Relative to other Past and Present Actions, SNWW 40-foot Project impacts are presented in Table 4.16-1.

4.16.3.2 GIWW – Texas Section, Main Channel and Tributaries

The USACE, Galveston District published "Maintenance Dredging, Gulf Intracoastal Waterway, Texas Section – Main Channel and Tributary Channels" (an EIS) in October 1975. This document identified and evaluated the environmental impacts of continued maintenance dredging of the GIWW Texas Section and tributary channels. The proposed action was continued maintenance by periodic dredging of shoal deposits. The main channel was authorized at a 12-foot depth and a 125-foot bottom width. The typical means of dredging is by hydraulic pipeline dredge, with the exception of the Port Mansfield Channel that can be maintained by either pipeline or hopper dredge. At the time of the 1975 EIS, the environmental impact and adverse environmental effects of the proposed action were addressed based on the best available information (USACE, 1975a, 2004c).

As it leaves Louisiana, the GIWW connects with the SNWW approximately 3 miles below Orange, Texas. The GIWW then follows the Sabine River Channel and the Sabine-Neches Canal to the head of the Port Arthur Canal where it exits the SNWW and continues westward to Galveston Bay. Portions of GIWW Reach I (Sabine River to the Matagorda Ship Channel) and tributaries are within the SNWW project area. Specific impacts for the GIWW segments within the SNWW project area are not distinguishable in existing documents, which present impacts of larger reaches of the GIWW. Potential impact presentation of the entire GIWW in this document would not be comparable to other projects presented here; therefore, GIWW impacts are not included in Table 4.16-1.

4.16.3.3 Neches River Saltwater Barrier Operating Plan

From 1975 through 1997, the USACE, Galveston District, with cooperation from the LNVA, pursued a project to prevent saltwater contamination of surface water supplies while maintaining free and reasonable unobstructed use of the Neches River for existing and future navigation (USACE, 1997a). Temporary steel-sheetpile barriers installed and controlled by the local sponsor at two locations down-stream from their freshwater intakes were environmentally and navigationally unacceptable. Environmental impacts were described in a 1975 FEIS and updated in a 1981 Supplement and 1997 EA; however, changes in environmental conditions and requirements necessitated an additional supplement.

The proposed project was revised in 1997 and relocated around river mile 29.7, downstream from the confluence of the Neches River and Pine Island Bayou, adjacent to the Big Thicket National Preserve. Installations and construction in approximately 60.4 acres include:

- an overflow dam with crown width of 300 feet in the Neches River;
- a sector gated 1,260-foot-long navigation bypass channel west of the river;
- a tainter gated 2,700-foot-long barrier structure in a diversion channel west of the navigation channel;
- an access levee road; and
- a service area west of the diversion channel.

Approximately 48.4 acres of the 60.4-acre project area involved vegetation removal and wetlands conversion, primarily in the form of cypress-tupelo swamp and bottomland hardwood habitats. The project identified the following environmental beneficial effects:

- set aside and protect 8.5 acres of cypress-tupelo swamp and additional modified mitigation strategy approved by the USFWS and USACE;
- prevent annual erosion and shoreline loss on the Big Thicket National Preserve;
- create 5 wetland acres around the "plug";
- conserve groundwater; and
- protect an additional 10 miles of river and bayou wetlands from saltwater intrusion and downstream pollutant contamination.

Additional net benefits were found through additional studies (USACE, 1997a): agricultural (primarily rice, cattle, turf grass, and crawfish); recreation (bird-watching, hunting, fishing); industrial (cooling and processing); and municipal uses.

No long-term permanent effects to wildlife, aquatic life, threatened or endangered species, water quality, air quality, noise, floodplains, cultural resources, or prime farmlands were expected (USACE, 2003c). An FEIS supplement was prepared in July 1981. A draft Environmental Assessment (EA), contained in the December 1997 General Reevaluation Report, concluded that the recommended plan would not have significant adverse environmental effects. The final EA was completed in October 1998. Construction of the Saltwater Barrier Project was completed in 2003. Current operational impacts are not known at the time of this document's production; however, impacts from the FEIS and the General Reevaluation Report are included in Table 4.16-1.

4.16.3.4 Salt Bayou – McFaddin Ranch Wetlands Salt Water Control Project

In 1992, the USACE, Galveston District, proposed modification of the GIWW by construction of a water control structure to improve fish and wildlife habitat on 60,000 acres of the wetlands of the McFaddin NWR, Sea Rim State Park, and J.D. Murphree WMA in Jefferson County, Texas (USACE, 1992). Prior to construction of the GIWW, the SNWW, and the Keith Lake cut, the area contained fresh to brackish marshlands drained by bayous and lakes to Sabine Lake. Disrupted natural drainage patterns and introduced salt water from the Gulf increased salinity in these marshlands causing loss of SAV, erosion, conversion to open water, and reduced wildlife habitat values. Actions to repair these conditions included installation of a concrete water control structure with five gated culverts on the GIWW at Salt Bayou; new channel excavation; training levee construction with stone riprap; and damming the outlet channel. It was determined that this project would have no significant impact on water quality, federally listed threatened or endangered species, National Register eligible properties, or floodplains (USACE, 1992). The project was intended to have a beneficial effect on approximately 60,000 acres of publicly owned wetlands and migratory waterfowl habitat. Although the barrier is functioning as intended, rainwater runoff exiting through the single remaining tidal exchange point at the Keith Lake Fish Pass has been insufficient to block significant saltwater intrusion, and marsh loss is still occurring.

4.16.3.5 Beneficial Uses of Dredged Material for Marsh Preservation, GIWW – Port Arthur to High Island, Texas

In 2003, the USACE Galveston District proposed BU of routine periodic maintenance dredged material along part of the Port Arthur to High Island reach of the GIWW, a 17-mile reach, which crosses the McFaddin NWR and J.D. Murphree WMA in Jefferson County, Texas. For this project, BU included berm creation and restoration along the channel to restrict saltwater intrusion into adjacent freshwater to intermediate marshes. Additionally, dredged material in existing PA No. 4 was allowed to flow over the rear levee into adjoining marsh to offset effects of subsidence. PA No. 4 is located in both the McFaddin NWR and J.D. Murphree WMA; new PAs as a result of this project were located within the McFaddin NWR and consist of narrow discharge corridors along the southern bank of the GIWW (USACE, 2003d). This plan was developed with the USFWS and TPWD, stewards of the NWR and WMA, respectively.

Overall, dredged material discharge impacts to marsh elevation and temporary salinity impacts to vegetation were considered minor relative to preserving and restoring adjacent marshlands. Wildlife disturbance was short term and localized during dredged material discharge operations. It was anticipated that some species of freshwater fish would benefit from the action, and the action would not affect EFH. No federally listed or proposed species were likely to occur at the project site and several State-listed species may have benefited from habitat loss prevention, restoration, and preservation. No historic properties were affected.

The project actions have no significant effect on maritime traffic along this reach of the GIWW. Vehicular traffic to an adjacent hunting lodge was blocked for 1 to 2 weeks, outside of the hunting season, to accommodate the discharge pipe. During dredging, the area immediately around the dredge and pipeline are hazardous (presence of equipment, increase in service boat traffic); however, these impacts to public safety are minor.

The Port Arthur – High Island Beneficial Use of Dredged Material impacts summary is presented in Table 4.16-1 for comparison to the SNWW CIP and other past, present, and reasonably foreseeable projects.

4.16.3.6 Sabine-Neches Waterway: Marine Organism Access between Placement Area No. 11 and Sabine Lake

In 1997, the USACE, Galveston District, proposed relocation of two drop-outlet structures, which allow clarified decanted water to exit PA No. 11 during dredged-material discharge operations. The relocation intended to enhance estuarine connectivity between PA No. 11 and Sabine Lake Estuary System and productivity within PA No. 11, between dredging cycles, by opening PA No. 11 to tidal exchange with Sabine Lake. Additionally, the work included removal of two existing spillways and closure of the connection between the drainage ditches and the Sabine-Neches Canal. The project was determined to have no significant adverse effect on human environment, fish, wildlife, water quality, threatened or endangered species, or historical resources (USACE, 1997b).

4.16.3.7 TxDOT Emergency Action Permit for Fill Along the Sabine River

TxDOT held an emergency permit valid through 2008 to conduct shoreline stabilization activities, as needed. The permit was valid for approximately 9 miles along the east and west shorelines of the Port Arthur Ship Channel, along SH 87 from south of the GIWW to northeast of Keith Lake, and along SH 82 from east of the GIWW to east of Keith Lake, south of Port Arthur in Jefferson County, Texas.

4.16.3.8 Habitat Protection and Restoration Projects

CWPPRA (PL 101-646), also known as the Breaux Act, provides Federal funding through the USACE to five Federal agencies cooperating with local funding-match sponsors to preserve and restore wetlands in Louisiana (LCWCR, 1998). The Breaux Act also established the Coastal Wetlands Conservation Grant Program to help preserve and restore other coastal wetlands with matching Federal funding in the U.S. and to assist programs under the North American Wetlands Conservation Act, passed in 1989. The Breaux Act designates that 70 percent of its authorized funds go to Louisiana restoration projects, 15 percent to the Coastal Wetlands Conservation Grant Program, and 15 percent to North American Wetlands Conservation Act projects. The Breaux Act Louisiana projects typically have a 20-year or less "lifespan" from planning through implementation and monitoring. As of 2004, approximately 129 projects were active from 13 Priority Project Lists (USACE, 2005c). Four recent projects within the SNWW study area were considered for the cumulative impacts assessment. The effects of these projects on land loss were considered in the WVA model analysis of each hydro-unit (Appendix C); they are combined in Table 4.16-1 under "Habitat Restoration Projects" as they are similar in location, type, action, and effect. A brief description of each project included in this analysis follows.

4.16.3.8.1 East Sabine Lake Hydrologic Restoration Project

The USFWS, NRCS, and LDNR designed and implemented a restoration strategy to prevent elevated salinity in freshwater areas of the western Sabine NWR, from Pool 3 to the eastern shoreline of Sabine Lake in Cameron Parish, Louisiana (LCWCR, 2003). Two construction phases started in 2004 and included shoreline armoring, revegetation, terracing, dike and levee systems, and other water control structure installations. Project actions are designed to prevent or restore events that affect the integrity and function of freshwater marsh areas in the refuge:

- prevent saltwater intrusion from the SNWW and the GIWW;
- restore natural water circulation;
- prevent rapid freshwater runoff;
- reduce marsh loss and subsidence, and
- reduce potential increased salinity from the Texas Water Plan (Senate Bill 1), the SNWW enlargement project, and the Neches River saltwater barrier north of IH 10.

The East Sabine Lake Hydrologic Restoration project area contains identified EFH for postlarval, juvenile, and subadult life stages of white shrimp, brown shrimp, and red drum (USFWS, 2004). The project area also provides important habitat for a number of economically important fishery species and migratory birds. The protected brown pelican may use the project area for feeding and/or loafing but is not known to nest in this area. The USFWS completed an intraservice Section 7 ESA consultation prior to issuing the Finding of No Significant Impact (FONSI) and Final EA and determined that the project would not adversely affect any threatened or endangered species within or adjacent to the project area. No cultural resources were identified within the work area. Habitat for fishery resources including EFH, migratory and resident waterfowl, wading birds, alligators, game mammals, furbearers, and brown pelican would be enhanced. Water quality and salinity are expected to show continual improvement. The total project effects/benefits include the following:

- 101.4 acres converted from shallow water to marsh, 1.4 acres filled by rock dike, and 163 acres of shallow water deepened for a total of 265.8 acres of shallow water filled or deepened; and
- 127.4 wetland acres protected and restored (USFWS, 2004).

4.16.3.8.2 Black Bayou Hydrologic Restoration Project

NOAA, NMFS, and LDNR sponsored and implemented a strategy to restore coastal marsh habitat and slow the conversion of wetlands to shallow, open water within a 25,529-acre wetland in Cameron and Calcasieu parishes, Louisiana (LCWCR, 2002a). The project area includes approximately 6,516 acres of fresh/intermediate marsh, 7,353 acres of brackish marsh, and 11,660 acres of open water (LDNR, 2003a). Tidally influenced intermediate and brackish marshes were threatened by saltwater intrusion and wave action amplified by the GIWW. Several actions were implemented:

- 22,600-foot rock dike constructed on the southern spoil bank of the GIWW;
- 70-foot bottom width barge bay weir in Black Bayou Cutoff Canal;
- 10-foot bottom width weirs with boat bays in Burton Canal and Block’s Creek;
- old, collapsed weir replacement with fixed crest steel sheet-pile weir including a self-regulating tidegate; and
- in situ terracing in open-water areas to create elevated marsh and marsh plantings.

Construction activities were completed in December 2001, and marsh planting began in April 2002. Monitoring was conducted in 2003 under a revised plan (LDNR, 2003a). Mean salinity calculated from continuous recorders and discrete data did not show any large differences between project and reference areas or between preconstruction and postconstruction conditions. However, discrete salinities were monitored from June 1999 through March 2004, and data suggest that the impounded hydrologic area 1 was minimally effective in reducing mean salinity and sharp salinity increases compared to the areas outside the influence of the project structures (LDNR, 2007). California bulrush plantings installed in 2002 were variably successful. No significant change in the shoreline location over 3 years was evident from the 2003 data. SAV coverage was very high in most of the ponds sampled in 1999 and remained high in 2003. Dominant species found at both sampling times include Eurasian watermilfoil, southern naiad (*Najas guadalupensis*), and the algae *Nitella* sp. An annual inspection conducted in October 2005 by the LDNR indicated that the project was in good condition and functioning as intended and that features survived Hurricane Rita basically intact (LDNR, 2005a). As of December 2006, an inspection field trip with the LDNR and NMFS detected two small breeches: one on the rock dike along the GIWW and one on a plug along the GIWW. As a result, discussions are underway to develop a plan for corrective actions (LCWCR, 2006). The project created a total of 2,960 acres of wetlands, protected 634 acres for a net total of 3,594 acres; 2,812 AAHUs are expected for this project (LCWCR, 2002a).

4.16.3.8.3 Perry Ridge Shoreline Protection Project

In February 1999, the NRCS and LDNR completed a limestone riprap dike within a 4.3-mile reach of the GIWW north bank and the Vinton Drainage Canal (LCWCR, 2002b). This dike (12,000 linear feet) is offset from the vegetated shoreline by 60 feet and is designed to break navigation-induced wave action, prevent further shoreline erosion, and reduce salinity spikes by maintaining a freshwater pool behind the rocks. The dike protects approximately 1,203 acres of vegetated shoreline, which, in turn, benefits approximately 5,945 acres of intermediate marsh north of the shoreline. The original monitoring plan was implemented following construction and has been revised in 1998 and 2003 to conform to similar monitoring projects (LDNR, 2003b). Approximately 624 acres of AAHUs are expected (LCWCR, 2002b). Results of the 2005 Operations, Maintenance, and Monitoring Report (LDNR, 2005a) indicate that the average rate of shoreline accretion was 1.6 feet/year at project stations, while reference stations showed a continued rate of shoreline erosion at 0.8 foot/year.

4.16.3.8.4 GIWW – Perry Ridge West Bank Stabilization

In 2002, the NRCS and LDNR completed installation of approximately 34,652 linear feet of rock riprap and terraces along the northern bank of the GIWW between Perry Ridge and the Sabine River in Calcasieu Parish, Louisiana (LCWCR, 2002c). This section of the GIWW was dredged to allow the use of doublewide barges, and consequently, wake erosion intensified. In addition, the construction of the Calcasieu Ship Channel and the deepening of Sabine Pass have increased salinity and water currents within the GIWW. These activities have caused the GIWW shoreline to breach, thus impacting the interior marsh of the Perry Ridge West Bank project area. The shoreline protection was accomplished in three phases:

- 9,500 feet of rock riprap along the northern bank of the GIWW from Perry Ridge to its intersection with the Sabine River;
- 2,200 feet of rock riprap from the Sabine/GIWW intersection north along the Sabine River; and
- 22,952 linear feet of terraces in the shallow, open-water areas north of the GIWW to reduce fetch (distance a wave can travel) and allow recovery of the interior marshes. Terraces were vegetated with 9,400 trade-gallon-sized plantings of California bulrush.

The net benefit in the 1,132-acre project area would be protection and restoration of approximately 83 wetland acres over 20 years (LCWCR, 2002c). This project (CS-30) is directly west of the Perry Ridge Shoreline Protection Project (CS-24) discussed above. According to the 2005 Operations, Maintenance, and Monitoring Report (LDNR, 2005b), visual observations indicate an increase in the SAV species in the project area and potential for accretion.

4.16.3.9 Sabine Pass LNG and Pipeline Project

The Federal Energy Regulatory Commission (FERC) issued an Order on December 21, 2004, granting approval under Section 3(a) of the Natural Gas Act (NGA) for Sabine Pass LNG, L.P.'s proposal (FERC Docket No. CP04-47-000) to construct and operate Phase I facilities at the LNG import terminal and granting approval under Section 7(c) of the NGA for 16 miles of 42-inch-diameter pipeline and associated facilities (called the Sabine Pass Pipeline). This order was based on, among other analyses, the FEIS, Sabine Pass LNG, and Pipeline Project (Phase I Project FEIS) published in November 2004 (FERC, 2004). Sabine Pass LNG, L.P., has subsequently applied for, and the FERC issued, an EA in May 2006 to expand facilities at the terminal (Phase II) (FERC, 2006a). The Sabine Pass LNG Terminal received its first shipment of LNG in April 2008.

The Sabine Pass LNG import terminal in Cameron Parish, Louisiana, includes the following:

- LNG ship unloading berths;
- LNG transfer, storage, and vaporization;
- packaged natural gas turbine/generator sets;
- ancillary utilities, buildings, and service facilities; and
- a new 16-mile, 42-inch-diameter pipeline system to deliver natural gas to existing pipeline infrastructure (FERC, 2004).

As documented in the FEIS, the Sabine Pass LNG project was expected to affect approximately 540 acres of open land, consisting of coastal prairie and grasslands, wetlands, and a Dredged Material Placement Area (DMPA). Approximately 35 acres were converted to open water, 36 acres were converted from shallow water to deep water, and 341 acres were affected by operational facilities. Construction and operation were anticipated to have minimal effects to geological and soil resources; no prime farmland soils were affected. No significant effects were anticipated to groundwater resources or public or private water supply wells. Surface water impacts included dredging approximately 4.5 mcy from the berth area and 69,000 cy from the construction dock area. Materials were moved to an unconfined BU area near Louisiana Point. Maintenance dredging is expected to occur every 4 to 7 years. Protective measures would be implemented to minimize impacts to surface waters. Although project actions resulted in temporary decreased water quality during and following dredge placement, potential future dredging benefits may include the following:

- Creation of a wave barrier to decrease wave energy along the shoreline, resulting in decreased shoreline erosion;
- Accretion of shoreline from redeposition of dredged material;
- Increased shallow-water habitat for marine and bird species that use shallow-water areas for foraging;
- Reoxygenation of sediments;
- Increase in wetland vegetation at water/shoreline interface due to increased shallow water and decreased wave energy; and
- Accretion of wetland habitats as high tide or storm events carry sediments into wetland areas

Approximately 156 acres of wetlands were expected to be affected by the LNG terminal development. Permanent wetland impacts included conversion of 17.4 acres of emergent wetland and 30 acres of DMPA to LNG terminal facility and 3.8 acres emergent wetland for a mainline valve on the pipeline. Less than 1 acre of forested wetland was converted to emergent wetland for pipeline operation. Additional wetlands impacts (approximately 27 acres) and mitigation (62 acres) were proposed when the USACE and LDEQ approved a permit amendment for Phase II (USACE, 2006d).

Wetlands in the Sabine Pass LNG and Pipeline project areas are designated as EFH for brown and white shrimp, red drum, and Spanish mackerel. Temporary EFH impacts during construction of the LNG terminal and pipeline totaled approximately 83 acres. Operation of the LNG and pipeline facilities was expected to permanently impact 15 acres of brackish marsh and mudflat wetlands and convert 36 acres of shallow open-water EFH to deep-water habitat. Wetland and EFH mitigation was proposed to enhance or create 73-wetland acres onsite, concurrent with the start of construction.

Of the 12 potentially occurring Federal- and State-listed threatened and endangered species, only the piping plover and brown pelican potentially occurred within the LNG project area. Critical habitat for the piping plover is designated at Louisiana Point, near the BU area for this project. With protective measures, construction and operation of the LNG terminal and pipeline facility were not expected to likely adversely affect either species or designated critical habitat. LNG ship encounters in the open water of the Gulf during transport create potential adverse effects to sperm whales, Kemp's ridley sea turtles, loggerhead sea turtles, green sea turtles, and leatherback sea turtles. As with the terrestrial species, protective measures and reporting procedures minimize these impacts.

At the time of construction, there were no residences within 1 mile of the LNG terminal location, and no residences within 50 feet of the pipeline work areas. No visual impacts were expected. No recreational facilities were directly impacted by construction or operation. It was anticipated that areas along the LNG ship route and around the terminal slip would be exposed to a potential temporary hazard during ship transit and while at the berth.

No prehistoric or historic cultural resources were located in the area of potential effect at the time of the FEIS publication; however, additional deep-water archeological testing and some remaining testing along the proposed pipeline route were conducted following the issuance of the FEIS. No known archeological sites or historic properties were affected by use of the Louisiana Point BU dredge disposal area. Construction air emissions were expected to be short term without adverse effect to regional air quality. Operational air quality was anticipated to exceed NO_2 and CO thresholds and was subject to State air permitting requirements.

The following plans were implemented to minimize impacts to potentially affected resources:

- Upland Erosion Control, Revegetation, and Maintenance Plan;
- Wetland and Waterbody Construction and Mitigation Procedures;
- Spill Prevention, Containment, and Countermeasures Plan;
- Aquatic Resources Mitigation Plan;
- Environmental Construction Plan and Procedures; and
- NOAA Vessel Strike Avoidance and Injured/Dead Protected Species Reporting (Strike Avoidance Policy).

The Sabine Pass LNG and Pipeline impacts summary is presented in Table 4.16-1, in comparison to the SNWW CIP and other past, present, and reasonably foreseeable projects.

4.16.3.10 Golden Pass LNG and Pipeline

In July 2005, FERC authorized (with conditions) Golden Pass LNG Terminal LP and Golden Pass Pipeline LP construction and operation of an LNG receiving and transportation facility northeast of Sabine Pass, Texas, adjacent to the Port Arthur Canal in Jefferson County, Texas (FERC, 2005). The project was designed to import, store, and deliver foreign-source LNG to natural gas markets and includes a marine ship berthing area, LNG storage tanks and vaporization facilities, and a natural gas pipeline. The 122.4-mile natural gas pipeline was completed in April 2009, 1 year ahead of schedule (FERC, 2006b). The pipeline would cross Jefferson, Orange, and Newton counties, Texas, and Calcasieu Parish, Louisiana. Although the facility was expected to open in mid 2009, damage caused by Hurricane Ike pushed the anticipated opening into 2010 (*Wall Street Journal*, 2008).

Measures would be taken to minimize impacts to soil and geological resources. Approximately 2.8 acres of prime farmland would be permanently affected. No impacts are anticipated to groundwater resources. Primary impacts to surface waters would be from construction, including dredging 6.3 mcy for the LNG terminal; this action would create approximately 63.9 acres of open water and convert 43 acres of shallow water to deep water. Maintenance dredging is expected to occur every 2 years and would result in an average of 410,000 cy per year. Dredged material would be pumped to PA 8 or PA 9, and approximately 1.2 mcy would be beneficially used for wetland restoration in the J.D. Murphree WMA. The proposed pipeline would cross the J.D. Murphree WMA. Approximately 0.5 acre of eroded shoreline would be reclaimed by filling the shallow-water area adjacent to the canal. Pipeline construction would minimize impacts to surface waters in 19 crossings using 31 horizontal directional drills.

It is anticipated that clearing and construction would affect approximately 2,007 acres of palustrine wetlands, estuarine emergent marsh, upland prairie, forest, agriculture and pastureland, and open-water/channel shoreline habitat. Approximately 239 acres of forested uplands and wetlands would be converted to herbaceous cover. Permanent vegetation effects would be approximately 227 acres for the LNG terminal and access road and 712 acres for the pipeline easement, aboveground facilities, and access roads (FERC, 2006b).

Golden Pass would affect approximately 399 wetland acres: 109 acres lost to LNG terminal facility development; 64 acres converted from forested to herbaceous or lost for aboveground facilities and access roads; and 226 acres affected by pipeline construction. Approximately 83 acres of forested wetlands would be cleared for pipeline right-of-way (ROW); of this, 40 acres would be maintained as herbaceous wetland within the ROW and the remaining 43 acres would eventually return to forested wetland areas. Pipeline construction would cross 14.9 miles of the J.D. Murphree WMA and nearly 1 mile of the Sabine Island WMA. The impacts to the forested wetland areas are considered permanent because of the time required for those wetlands to naturally recover to preproject conditions. Three years of invasive species control would be performed along the pipeline route to facilitate native species' success. Routing would minimize wetlands impacts on J.D. Murphree WMA, and directional drilling would minimize impacts to the Sabine Island WMA. Permanent impacts to wetlands would be mitigated through the following actions:

- creation of approximately 244 acres of vegetated wetland within the J.D. Murphree WMA;
- purchase of an 829-acre tract (195.5 acres forested wetlands, 7.6 acres emergent and scrub shrub wetlands, 18.8 acres forested riparian corridor, and 603.2 acres upland mixed-age pine stands) adjacent to the Big Thicket National Preserve; and
- purchase of 50 acres from The Nature Conservancy's Southwest Louisiana Pine Wetland Mitigation Bank to compensate for the forested wetland impacts within the Calcasieu River watershed.

The Golden Pass projects would affect just over six marshland acres designated as EFH for several life stages of red drum, Spanish mackerel, and white and brown shrimp. Deep, open-water EFH may be created by berth and marine basin dredging, providing habitat for some lifestages of some species. Of 15 potentially occurring federally and State-listed threatened and endangered species, the projects may affect only the red-cockaded woodpecker.

Thirty-three residences are within 1 mile of the proposed LNG terminal. Visual and land use impacts would occur in limited areas; however, Golden Pass would implement special construction techniques to minimize land use impacts to affected residences. The Texas State Historic Preservation Officer (SHPO) has concurred that no historic properties would be affected by the LNG terminal; however, the pipeline system consultation is not complete. Investigations and consultation indicate that buried cultural resources and the viewshed and cultural landscape of historic structures may be affected by the pipeline system.

The following plans would be implemented to minimize impacts to potentially affected resources:

- Spill Prevention, Containment, and Countermeasures Plans;
- Storm Water Pollution Prevention Plan;
- Upland Erosion Control Plan;
- Revegetation and Maintenance Plan;
- Wetland and Waterbody Construction and Mitigation Procedures; and
- Aquatic Resources Mitigation Plan.

The Golden Pass LNG and Pipeline impacts summary is presented in Table 4.16-1, in comparison to the SNWW CIP and other past, present, and reasonably foreseeable projects.

4.16.3.11 Kinder Morgan Louisiana Pipeline

Kinder Morgan Louisiana Pipeline LLC has obtained authorization to construct and operate a 140-mile pipeline system in Cameron, Calcasieu, Jefferson Davis, Acadia, and Evangeline parishes, Louisiana (FERC, 2006a; 2007). The proposed Kinder Morgan Louisiana Pipeline is designed to transport regasified natural gas from the Sabine Pass LNG Terminal to various intrastate and interstate natural gas pipeline systems, delivering a peak day capacity of not less than 3,395,000 decatherms.

The pipeline system would consist of three pipelines and associated pipeline support facilities, including pig launchers and receivers and metering equipment. Leg 1 of the pipeline consists of approximately 130 miles of 42-inch-diameter pipeline originating at a receipt point within the Sabine Pass LNG Terminal and terminating at an interconnection with an existing Columbia Gulf Transmission interstate pipeline in Evangeline Parish, Louisiana. Leg 2 is an approximately 0.4 mile of 36-inch-diameter pipeline originating at a receipt point in the Sabine Pass LNG Terminal and terminating at an interconnection with the existing Natural Gas Pipeline Company of America north of the LNG terminal. The third pipeline originates at the termination point of Leg 1 and would not have impacts within the SNWW study area. Fifteen new lateral pipelines from the proposed pipeline interconnecting sites to existing interstate pipelines are expected to be constructed by separate entities.

The FEIS was issued in April 2007 (FERC, 2007). Specific resource impact information for the Kinder Morgan Louisiana Pipeline is included in Table 4.16-1. The corridor for Leg 1 is located in the SNWW study area; it commences from the Sabine Pass LNG terminal, proceeds north across Sabine Lake, up the Sabine River, and then turns eastward along the GIWW. The corridor in Sabine Lake was designed to avoid impacts to the extensive oyster reefs near Blue Buck Point and does not impact other oyster reef or habitat. Pipeline construction was expected to result in permanent impacts to 0.8 acre of brackish marsh in the SNWW study area. Compensatory mitigation for these wetland impacts consisted of marsh restoration and preservation through the creation of 5,511 linear feet (2.53 acres) of wave-dampening terraces.

4.16.3.12 Jefferson County Drainage District No. 6 Taylor Bayou Flood Reduction Project

The Jefferson County Drainage District No. 6 (JCDD6) received a Department of Army permit in 2007 to construct flood control improvements to Green Pond Gully, Willow Slough, and Taylor Bayou, southwest of the city of Beaumont, in Jefferson County, Texas (USACE, 2006e, 2007c). Actions will include regional detention and levee construction, channel improvements, and the construction of a diversion channel (known as the Needmore Diversion Channel) from near the confluence of the North and South Forks of Taylor Bayou south to the GIWW. The Green Pond Detention Basin, levee construction, channel modifications, and Needmore Diversion Channel will be undertaken as part of flood reduction measures for the Taylor Bayou watershed. The Green Pond Detention Basin will be a 9,000-acre, aboveground detention facility located between Lawhorn Road, Farm-to-Market Road 365, South China Road, and Gallier Canal, with a maximum storage capacity of 15,000 acre-feet. The Needmore Diversion Channel is a 63,000-foot-long, 14-foot-deep, 200-foot-wide bottom channel within a 1,000-foot-wide ROW extending from near the confluence of the North and South forks of Taylor Bayou to the GIWW. Rectification of several man-made channel restrictions are included along portions of the North Fork of Taylor Bayou at Craigen Road, SH 124, IH 10, between Crystal Lakes, and between IH 10 and Green Pond Gully to restore and improve the flood flow characteristics of the waterway. The project will result in the direct impact to 692.4 acres of jurisdictional wetlands and 337.2 acres of nonjurisdictional low-to-high-quality forested and medium-to-high-quality herbaceous wetlands.

To offset impacts for the project, the JCDD6 has agreed to preserve 538 acres of wetlands adjacent to Spindletop Bayou and an additional 1,926 acres of forested wetlands and uplands within the Green Pond facility. An additional 7,000 acres will have restricted land use to preserve the area from development. A total of 44 acres of wetlands and riparian forest within or adjacent to the Needmore Diversion (40 acres of wetland shelf within the channel and 4 acres of riparian wooded corridor along the east border of the channel from Taylor Bayou south to Willow Slough) will also be created. In total, mitigation will consist of the preservation of approximately 2,464 acres of wetlands and wetland forests and the creation of 44 acres of wetlands and riparian forest to compensate for impacts to approximately 692 acres of jurisdictional waters and wetlands. To ensure that impacts to water quality in Taylor Bayou are minimized, the project design includes a flap gate structure at the Needmore Diversion Channel's south end to eliminate the possibility of saltwater intrusion in periods of reduced freshwater inflows and during storm surge events. In addition, the diversion channel's input from the South Fork of Taylor Bayou will be controlled to take only floodwaters above elevation 5.2 feet mean sea level ensuring that normal flows of Taylor Bayou are not impacted and only severe flood events are reduced in size and duration by the proposed diversion channel. At issuance, all required Federal, State, and/or local authorization or certifications had been obtained except for water quality certification and coastal zone consistency certification. JCDD6 stated that the project is consistent with the Texas CMP goals and policies and would be conducted in a manner consistent with that program and that water quality certification would be obtained from TCEQ.

A historic properties investigation has been conducted within the permit area, and no sites determined eligible for or listed on the NRHP are within the permit area or affected area. No known threatened and/or endangered species or their critical habitats are likely to be adversely affected by the proposed work. The action is not anticipated to have a substantial adverse impact on EFH or federally managed fisheries in the Gulf. Specific resource impact information for the Taylor Bayou Flood Reduction Project is included in Table 4.16-1.

4.16.4 Reasonably Foreseeable Future Actions

4.16.4.1 Port Arthur LNG and Pipeline

Port Arthur LNG, L.P., and Port Arthur Pipeline, L.P., proposed construction of a new LNG import terminal and pipeline system in Jefferson County, Texas (FERC, 2006c). The facility includes LNG ship unloading berths, LNG storage and vaporization, and a new 73-mile, 36-inch-diameter natural gas pipeline system to deliver the natural gas to existing interstate and intrastate pipeline systems. The project was authorized by FERC in 2006 and would be constructed in two phases over approximately 10 years.

Geological resources would be minimally affected. Erosion control devices and plans would reduce shoreline erosion and flooding effects from storm events. Adverse effects to groundwater and water supplies are not anticipated. Impacts to surface waters would be primarily from the 6.7 mcy of material dredged for the LNG ship berths and turning basin, pumped to an existing DMPA onsite for beneficial reuse. Approximately 82 acres of land would be converted to open water. Fourteen areas would be horizontally directionally drilled to minimize potential adverse water quality effects from the pipeline crossing several major waterbodies.

Clearing and construction would impact 1,497 acres of palustrine, scrub-shrub, and forested wetlands; estuarine emergent marsh; coastal prairie/grasslands; coastal woodlands/upland forests; agriculture and pastureland; disturbed lands; and, open-water/channel shoreline habitats. Operational (permanent) vegetation impacts would include approximately 198 acres for the LNG terminal and 87 acres (forest to herbaceous conversion) for the pipeline. Construction of the proposed LNG facility and pipeline would result in impacts to approximately 391 acres of wetlands, of which 96 acres would be permanent (83 acres for LNG terminal facility and 13 acres for the pipeline). Approximately 13 acres of the pipeline system permanently impacted wetlands would be converted from forested to herbaceous cover. The remaining 295 acres of impacted wetlands would be restored and allowed to revegetate to preconstruction conditions.

The Port Arthur LNG terminal and pipeline projects would affect a total of 456 acres of estuarine and deep-water habitats designated as EFH for several life stages of red drum, Spanish mackerel, white and brown shrimp, and bonnethead shark (*Sphyrna tiburo*). Eighty-two acres of deep, open-water EFH may be created by berth and marine basin dredging, providing habitat for some lifestages of some species. Of 22 potentially occurring Federal- and State-listed threatened and endangered species, the projects are not likely to adversely affect any of these species or their designated critical habitats.

No residences occur within 1 mile of the proposed LNG terminal and three residences occur within 50 feet of the proposed pipeline work area. Land use and visual impacts are likely. Site-specific construction plans would be implemented to minimize effects to these residences during construction. No direct effects are anticipated to the private, State, and Federal recreation and conservation areas in the Louisiana or Texas. CZMP consistency determinations have been issued by Louisiana and Texas. Two cultural sites within the terrestrial portion of the proposed construction area have been assessed as potentially eligible for listing in the NRHP. Additionally, seven magnetic and/or acoustic anomalies have been detected where the pipeline would cross Sabine Lake. Studies and avoidance/mitigation measure planning efforts are in progress.

If unmitigated, direct and indirect emissions during the LNG terminal operation would exceed de minimis air quality conformity thresholds. Mitigation measures would be implemented, preventing increase of emissions with respect to future baseline emissions. Operational risks to public health and safety would be none to minimal, depending on the location and activity. The moving safety zone, moored vessel security zone at the terminal, and one-way traffic areas would affect other commercial and recreational traffic using the SNWW.

The following minimization and protection plans would be implemented to address unavoidable impacts:

- Spill Prevention, Containment, and Countermeasures Plans;
- Storm Water Pollution Prevention Plan;
- Upland Erosion Control Plan;
- Revegetation and Maintenance Plan;
- Wetland and Waterbody Construction and Mitigation Procedures;
- Aquatic Resources Mitigation Plan (primarily for wetlands); and
- LNG Vessel Management and Emergency Plan.

The Port Arthur LNG and Pipeline impacts summary is presented in Table 4.16-1, in comparison to the SNWW CIP and other past, present, and reasonably foreseeable projects.

4.16.4.2 East Texas Regional Water Plan

The 2007 Texas State Water Plan is the eighth water plan developed by TWDB as a part of its core mission to ensure that sufficient, clean, and affordable water supplies are available for the citizens of the State of Texas and that those water supplies foster a healthy economy and environment (TWDB, 2007). The plan was developed from May 2005 to August 2006 and approved in November 2006. The state plan includes participation from 16 regional groups (TWDB, 2007).

The ETRW Planning area includes all or part of 20 counties, from Beaumont, Port Arthur, and Orange counties north to Tyler County, spanning from the Texas-Louisiana border east to the Trinity River Basin boundary. Three surface water river basins (Sabine, Trinity, and Neches) and four aquifers (Gulf Coast, Carrizo-Wilcox, Sparta, and Queen City) serve the water uses in the region. The Neches-Trinity Coastal Basin and approximately 1 square mile of the Cypress Creek Basin are also partially encompassed in the planning area. The 2006 ETRW Plan that was adopted as part of the 2007 Texas State Water Plan seeks to address a projected 41 percent increase in water demand from 2010 to 2060 through several strategies (TWDB, 2007):

- construction of a new reservoir, Lake Columbia (Eastex) on Mud Creek (tributary of the Angelina River) in Cherokee County, Texas (approximately 187,839 acre-feet);
- negotiated use of adjacent Region C surface water supplies, Toledo Bend Reservoir (existing), and Lake Fastrill (not yet constructed on the Neches River);
- expanded groundwater use based on long-term sustainability;
- municipal conservation through plumbing code implementation and public education to save over 20,600 acre-feet of water annually by 2060;
- City of Athens indirect reuse of wastewater discharge, returning a portion of treated wastewater to Lake Athens, the city's primary water supply; and
- policy recommendations.

The ETRW Plan is consistent with protection of agricultural, public, park, oil, gas, and coal production resources. The development of Lake Columbia and Lake Fastrill may affect several resource classes, including timber, State- and Federal-threatened and/or endangered species, water resources, and others; however, these reservoirs would not be within the SNWW project area. Lake Columbia is anticipated to inundate approximately 10,000 acres. Lake Fastrill would inundate approximately 24,950 acres, including a portion of the proposed USFWS North Neches NWR. Site-specific information to identify wetlands, bottomland hardwoods, ecologically significant stream segments, Sabine-Neches estuary freshwater inflow needs, cultural resources, and prime farmland sites is currently not available. Because specific resource impact information is not available at this time, strategies discussed in the ETRW Plan are not included in Table 4.16-1.

4.16.4.3 Port of Beaumont Intermodal Improvement Projects

Both the Southside and Northside intermodal improvements projects have received funding from the H.R. 3 Transportation Bill. The Southside Project would provide infrastructure modifications and facilities expansion for direct intermodal interchange, transfer, and access for the Port of Beaumont to improve access and operation capabilities. The project would include rail holding tracks and loading ramps, and would increase the port's railcar storage capacity by about 75 percent. Operational efficiency and security would be enhanced by relocating the interchange tracks to expanded facilities at the terminal (Port of Beaumont, 2005a).

The Northside Intermodal Improvements Project would fund development and construction of an access road to connect IH 10 to port-owned property on the north bank of the Neches River. Additional funding was received for a rail infrastructure improvement project under a Federal program designed to promote air quality and congestion reduction (Port of Beaumont, 2005b).

These projects, combined, are expected to:

- Enhance the port's capacity for railcars
- Improve the port's ability to handle military cargo
- Enhance security for military and other cargo
- Increase the efficiency of port operations
- Make downtown riverfront property available for commercial development
- Provide significant growth opportunities for development of the port's northbank property in Orange County, Texas

In addition to projects outlined above, additional Port of Beaumont improvements include:

- A general cargo wharf
- A new dock office
- A new building for the port's military customers
- Repairs of bulkheads and upgrades of lots
- New double layberth for military vessels and new 90,000-square-foot transit shed on the Orange County, Texas, side
- Extend main Harbor Island east wharf with new transit shed on Beaumont side – new 680-foot extension to Harbor Island wharf, and linking railroad tracks on the new wharf to existing tracks. Project is meant to relieve berth congestion at the terminal.

Specific resource impact information is not available at this time; therefore, the Port of Beaumont intermodal improvement projects' potential impacts are not included in Table 4.16-1.

4.16.4.4 Keith Lake Fish Pass Ecosystem Restoration Section 1135 CAP

Keith Lake Fish Pass is located in Jefferson County, Texas, approximately 15 miles south of Port Arthur and intersects SH 87. The pass is approximately 0.3 mile south of the GIWW and on the west bank of the Sabine-Neches Ship Channel south of Port Arthur. The pass connects Keith Lake to the Port Arthur Canal and is part of a drainage system that impacts about 60,000 acres of wetlands (10,000 acres of coastal marsh habitat) in McFaddin NWR, Sea Rim State Park, and J.D. Murphree WMA in the Neches River delta. At 10,000 acres, the Keith Lake watershed contains approximately 8 percent of existing Texas coastal estuarine marshes. Assuming no increase in the rate of marsh loss from the most recent estimates, approximately 3,460 acres (or 35 percent) of brackish marsh in the Keith Lake watershed would be lost during the next 50 years (USACE, 2002).

Area marsh has been adversely affected by saltwater intrusion and high-energy inflows resulting from an obsolete and unrefurbishable 1933 USACE structure and the impacts of the 1974 USDA "water exchange pass" project, now known as the Keith Lake Fish Pass. The pass was created to improve water circulation into the Salt Bayou Drainage system and was a 3,600-foot straight-line canal, 155 feet wide and 5 feet deep with 2:1 side slopes. Higher-than-expected water volume and velocity have eroded the pass to 240 feet wide and 7 feet deep since 1977. The cut has improved the amount and variety of marine species in the area; however, the marsh system has been degraded by high salinity levels and hydraulic energy impacts from the ship channel.

Emergent coastal wetland habitats and wetland soils loss has been accelerated in Jefferson County, Texas. Open water is formed when salt-intolerant vegetation dies and the underlying organic topsoil material erodes away before the succession of salt-tolerant vegetation can take place. The area is vital nesting and brooding habitat for mottled ducks, with an increasing amount of nesting by fulvous whistling duck (*Dendrocygna bicolor*) and black-bellied whistling ducks (*D. autumnalis*). Several species of migratory birds traveling the Central Flyway use the area as a rest stop or staging area.

Jefferson County, Texas, and USACE, Galveston District, with support from the TPWD, GLO, and TWDB, are studying ways to reduce the amount of saltwater intrusion and decrease high-energy inflows entering the marsh, thus slowing marsh habitat loss. The goal of the study and any recommended conservation measure is to sustain and protect over 60,000 acres of brackish coastal marshes within the Saltwater Bayou Watershed, including approximately 2,600 acres in the Keith Lake system. As yet, undetermined measures must assist in achieving the objective presented in the Salt Bayou Project Joint Management Concept Plan for Sea Rim State Park, McFaddin NWR, and J.D. Murphree WMA (August 1990). The TPWD is developing alternatives and potential impact information for the Keith Lake Fish Pass project is not currently available to include in Table 4.16-1.

4.16.4.5 Sabine Pass to Galveston Bay Shoreline Erosion Project

The purpose of the Sabine Pass to Galveston Bay Shoreline Erosion Feasibility Study is to address the severe shoreline erosion occurring along the upper Gulf Coast of Texas between the SNWW (Sabine Pass) and the Galveston Entrance Channel (Galveston Bay) and the entire Gulf shoreline of Galveston Island (USACE, 2004b). The study area consists of approximately 90 miles of Gulf shoreline in Jefferson, Chambers, and Galveston counties along the upper Texas coast from Sabine Pass to San Luis Pass at the western end of Galveston Island. The major problems identified in the reach to the north of Galveston Bay result from shoreline erosion and include the potential destruction of nationally significant wetlands, loss of land and damage to homes and commercial properties, and significant damage to SH 87. The Sabine Pass to Galveston Bay Shoreline Erosion Project is in the planning stages, and no information regarding potential impacts is available for Table 4.16-1.

4.16.4.6 Toledo Bend Reservoir Relicensing

Toledo Bend Reservoir is located on the Sabine River in Texas and Louisiana and forms a portion of the boundary between the two states. The reservoir is approximately 65 miles long and inundates land in Newton, Sabine, Shelby, and Panola counties, Texas, and Sabine and DeSoto parishes, Louisiana. Toledo Bend Reservoir has 1,200 shoreline miles, normally covers an area of 185,000 acres, and has a controlled storage capacity of 4,477,000 acre-feet. The reservoir was constructed by SRA-TX and Sabine River Authority of Louisiana (SRA-LA) for water supply with secondary uses of hydroelectric power generation and recreation. On December 12, 2002, the SRA-TX approved an application to TCEQ to amend Certificate of Adjudication No. 05-4658 to include the right to divert 293,300 acre-feet per year of the available portion of the stored Texas water from Toledo Bend Reservoir for multiple use (municipal, industrial, agricultural) (SRA-TX and LNVA, 2006). TCEQ is mandated to consider environmental flows (instream and freshwater needs) during permit evaluations for new reservoirs or amended water rights.

The SRA-TX and SRA-LA have initiated the process to renew the FERC license that allows the generation of hydroelectric power. The current FERC license expires October 14. 2013. The intention of SRA-TX and SRA-LA is to continue current operations as a hydropower peaking unit during the summer months. However, as water supply sales increase, hydropower generation may be reduced.

The Authorities submitted a Notice of Intent to file an application for a new license and request designation as non-Federal representatives in September 2008, and a Proposed Study Plan in July 2009 to FERC (SRA, 2009), but specific resource impact information is not available at this time; therefore, the Toledo Bend Reservoir Operating Plan and potential FERC relicensing potential impacts are not included in Table 4.16-1.

4.16.4.7 Cameron Parish Dredge Project

Cameron Parish Gravity Drainage District #7 proposes to dredge 6,970 feet of Johnson’s Bayou to remove debris and sediments deposited during Hurricane Ike. Material would be placed into an upland confined PA. No wetland impacts would occur. Also, preliminary coordination determined no substantial effects, and no effects to EFH and threatened or endangered species, respectively. Information available is minimal, and this project is not included in Table 4.16-1.

4.16.4.8 Taylor Bayou Canal Seven Gate Saltwater Barrier

Located at the existing Taylor Bayou Canal Seven Gate Saltwater Barrier at the intersections of the Taylor Bayou Canal and Taylor Bayou, the SNND proposes to construct four additional saltwater gates. This effort would include 137-x-40-foot pile-supported slap and gate walls, 98 feet of concrete wing wall, 3,000 cy of riprap, 6,500 feet of 8-inch conduit, replacement of the control building (which was destroyed by Hurricane Ike), and 50,000 cy of material acquired from dredging. Impacts would involve 2.3 acres of wetland. Information available is minimal, and this project is not included in Table 4.16-1.

4.16.4.9 Study Area Habitat Protection and Restoration Actions

Four projects are currently planned in the study area that target protection and restoration of wetlands and include the Star Bayou/Rose City Mitigation Bank, and three restoration and enhancement projects at McFaddin NWR.

The Star Bayou/Rose City Mitigation Bank would require dredging of Star Bayou (400-x-200-foot area) to acquire 26,000 cy of material. This material would be used to construct, restore, and enhance wetland areas at part of another ongoing mitigation effort in the Rose City Marsh Complex Habitat Restoration

Area. Although temporary impacts may occur from dredging, the project would result in long-term beneficial effects to wetlands in the study area.

The USFWS proposes to rehabilitate earthen levees and install water control structures at two locations on McFaddin NWR. The first project, Big Hill Unit Restoration, would involve acquisition of 534,000 cy of dredged material for 8,900 feet of levee rehabilitation along Lost Bayou. Also, 400 feet of new levee would be created. Water control structures would be used to manipulate freshwater inflows from Willow Slough, and general aquatic habitat management. Although 0.18 acre of wetlands would be filled through these actions, the overall long-term effect of the project would result in net benefits to the study area wetland complexes.

The second project, Clam Lake Restoration Project, would create a 625-square-foot levee with control structures within wetlands. Material for levees would come from immediately adjacent areas. Although the project would fill 2.94 acres of marsh and excavate another 3.67 acres, project goals include saltwater intrusion protection for 1,500 acres of wetlands within the Wild Cow Bayou Unit, restoration of 248 acres of marsh, and enhancement of 730 acres of wetlands adjacent to 10-mile Cut.

The third project on McFaddin NWR would involve the placement of 12,132 linear feet of graded rock serving as a breakwater structure for protection along an eroded shoreline along the north side of the GIWW. The breakwater would be approximately 25 feet wide at the base, 3.5 feet high in the center, 20 to 40 feet from the existing eroded bank, resulting in 43,570 cy of fill below the mean high tide line. No direct wetland impacts would occur, and the breakwater may have beneficial effects to adjacent wetlands.

Information on these four protection and restoration projects was limited and only included wetland impacts (or indirect effects) that would all be beneficial to study area wetland complexes. No other information regarding potential project effects associated with the cumulative impacts analysis was available, and thus these projects are not included in Table 4.16-1.

4.16.4.10 Sabine Lake Oil and Gas Projects

Eight oil and gas projects are planned for Sabine Lake that would impact regulated waters and include four exploration wells (El Paso E&P Co.), three flowlines (El Paso E&P Co.), and one oil and gas drilling, production, and transportation facility (Shoreline Southeast LLC).

Four exploration wells occurring in Sabine Lake would involve minimal discharge of materials into regulated waters. All four projects combined are anticipated to impact a total of 0.14 acre of bay bottom, and no mitigation is proposed. These projects would not cause long-term detriment to the study area's aquatic resources.

The three proposed flowlines in Sabine Lake are 6-inch diameter and would be jetted into place about 3 feet below mudline. All of these projects combine for a total of 0.43 acre of impacts to bay bottom, and no mitigation is proposed. These projects would not cause long-term detriment to the study areas aquatic resources.

Information on these Sabine Lake oil and gas projects was limited and only included regulated waters impacts. No other information regarding potential project effects associated with the cumulative impacts analysis was available, and thus these projects are not included in Table 4.16-1.

4.16.5 Cumulative Impacts Results

The following sections provide discussion of the potential cumulative impacts summarized in Table 4.16-1, which may result from the Preferred Alternative combined with past, present, and reasonably foreseeable actions within the Study Area.

4.16.5.1 Ecological and Biological Resources

Ecological and biological resources are expected to experience short-term temporary adverse effects resulting from increased turbidity, disturbed bottom, and placement of dredged material during construction and maintenance operations. Some permanent impacts are expected to wetlands; however, these are to be offset by the benefits of BU features and compensatory mitigation for each project considered in this assessment.

4.16.5.1.1 Wetlands

All projects considered in this analysis have compensatory measures and/or minimization or mitigation plans to address wetland loss and/or impacts. In total, the restoration activities, purchased-and-protected areas, and created wetlands offset impacts within and adjacent to the project area, resulting in a net gain of wetland acres (approximately 10:1). This net gain is not always type-for-type; conversion of forested wetlands is considered permanent loss given the time it takes to recover mature forested wetlands and the high potential for invasive species colonization. Overall, cumulative impacts to wetlands are not expected to be significant with implementation of the Preferred Alternative's Mitigation Plan.

4.16.5.1.2 Bottomland Forest

The Preferred Alternative causes no loss of forested wetland acreage (either swamp or bottomland hardwood) throughout the study area. Salinity impacts to the forested wetlands on the Neches River are avoided by DMMP hydrologic and marsh restoration on the river. Salinity impacts to swamps on the Sabine River are related to a minor decrease in the function of the ecological system, as conservatively estimated in the WVA model (Appendix C) by comparison to maximum growth under optimal conditions. The loss in function is considered to be negligible since projected salinity levels are within the tolerance levels of the swamps.

4.16.5.1.3 Terrestrial Vegetation

Terrestrial vegetation impacts occur on most projects considered in this cumulative impacts assessment. Clearing for construction, ROW maintenance (trimming and mowing), prescribed burning, conversion to open water, and dredged material placement may affect terrestrial vegetation. The conversion of forested areas to herbaceous cover or open land or water is the most significant impact as the time to recover forest vegetation communities is significantly longer than that to recover herbaceous habitats, without active intervention. Additional impacts stem from the invasion of non-native fast-colonizing species in disturbed areas.

Upland vegetation on any PA would be covered by dredged material deposition; however, this vegetation consists of mostly opportunistic species, which would recolonize easily once the site has been dewatered. Herbaceous cover impacted typically recovers in a reasonable timeframe with the implementation of erosion control measures. Several of the projects considered in this assessment have invasive species monitoring and control measures, forest land impact minimization actions, or net beneficial actions (such as native prairie restoration and prescribed burning or replanting disturbed areas), which can reduce the loss of native terrestrial vegetation.

In the Preferred Alternative, a total of 86 acres of marsh would be converted to upland confined PAs. The loss of biological function and acreage is fully compensated by DMMP restoration plans resulting in a net increase in coastal marsh acreage in the project area. Cumulatively, the SNWW does not contribute to terrestrial vegetation loss or impacts.

4.16.5.1.4 Submerged Aquatic Vegetation

Physical impacts to SAV may result from projects augmenting marshlands, protecting shoreline, and affecting wetlands. Additionally, increased salinity resulting from the Preferred Alternative and other projects included in this analysis could affect submerged vegetation and related habitats. Marsh restoration and DMMP restorations and nourishment measures offset adverse effects associated with the Preferred Alternative. Additionally, the Preferred Alternative would increase the amount of shallow-water areas and reduce wave action in certain areas, making conditions more conducive to SAV recruitment and growth, effectively resulting in a net increase of SAV in the study area.

4.16.5.1.5 Plankton and Benthos

Placement of dredged material in offshore placement sites would bury benthic organisms incapable of escaping or burrowing up through the dredged material. Only the dredge projects considered in this document would affect benthic organisms in the study area through this method. Recolonization is expected; however, benthic community structure and abundance may be altered as early successional recovery stages are not necessarily the same as those buried by excavated materials. Additionally, repeated localized dredging in one place may prevent full benthic community development and shift community structure since overall benthic impacts affect a very small percentage of water bottom in the study area. It is possible that the new community would still provide adequate food source for the aquatic community. Excavation would increase turbidity levels and may provide cover benefits to certain organisms. In general, all projects considered in this cumulative impacts assessment have the potential for short-term negative impacts; none of the coverage or turbidity impacts are expected to adversely affect benthic organisms or plankton. Minimization and mitigation measures to restore, enhance, and augment estuarine environments and shorelines would likely provide a net benefit to these organisms.

4.16.5.1.6 Essential Fish Habitat

The Sabine Pass LNG and Pipeline, Golden Pass LNG and Pipeline, and the Preferred Alternative have the potential to affect EFH through excavation and dredged material placement in open-water PAs. These activities could affect food sources in EFH and increase turbidity. Dredged material associated with these projects that would be placed in open-water sites would not contain contaminants, as determined by the EPA and USACE review and permitting. Additionally, loss of shallow-water habitats from some of the projects' activities considered in this analysis may adversely affect EFH for lifestages of several species; however, the Preferred Alternative's proposed actions would result in a net benefit to EFH through marsh creation and reduced impacts to SAV.

4.16.5.1.7 Threatened and Endangered Species

Most of the projects included in this assessment are not expected to or did not significantly impact federally listed threatened or endangered species. In general, the species potentially most affected are sea turtles during hopper dredging activities and piping plover during dredged material placement. While turtle mortality is a possibility, the USACE-NMFS sea turtle avoidance and documentation procedures established for hopper dredging activities and applied during all projects using hopper dredges significantly reduce the likelihood of adversely affecting protected sea turtles. In relevant projects' assessment documents, piping plover populations and designated Critical Habitat were determined to not be affected. Food species potential impacts are short term and recoverable, based on all assessments.

4.16.5.2 Physical and Chemical Resources

4.16.5.2.1 Air Quality

Objectionable odors (mercaptan, hydrogen sulfide) may result from construction and maintenance excavation and/or dredging of sediments containing high concentrations of organic matter. Several of the projects in this assessment document that NO_x and CO emissions would occur during dredging and/or excavation equipment activities. These activities are considered temporary and intermittent. Most of the projects considered in this analysis lie within or adjacent to the BPA Ozone 8-hour Nonattainment Zone, which includes Jefferson and Orange counties. All projects within the study area with the potential to affect air quality must conform to the TCEQ SIP. Coordination and compliance with the TCEQ and EPA would result in no significant cumulative impacts to air quality within the study area.

4.16.5.2.2 Noise

Temporary noise impacts would result from construction and maintenance dredging activities, which would change with location, depending on the section being dredged. It is unlikely that dredging would occur for more than one of the reviewed projects at one time.

4.16.5.2.3 Topography, Bathymetry, Soils, Sediment Quality

Terrestrial and marine contours would be permanently changed in construction and maintenance dredging projects, but not by most of the LNG and pipeline projects (which state that temporarily impacted project areas would be returned to preconstruction contours). Topography and bathymetry would be cumulatively changed (increased) in upland and offshore PAs as a result of dredged material deposition. Most soil impacts in all projects are considered temporary and/or recoverable given best construction and erosion control practices, including protection measures implemented as a result of stormwater permitting and water quality certification. No significant impacts to sediments or from sediments are expected, except that there may be an increased risk of spill during construction of the reasonably foreseeable projects included in this analysis.

4.16.5.2.4 Water Quality

For those projects that include dredging activities, dredging and placement operations are expected to temporarily degrade water quality in the project vicinity through increased turbidity and nutrient releases from the sediment. Dredging placement is not expected to affect water quality as much of the construction and maintenance material would be used beneficially and the rest would go into PAs. For the most part, salinity increases for the projects considered in this analysis were negligible, within natural fluctuation ranges, or offset by mitigation or protective measures. Increased ship traffic in the study area could increase the risk of a toxic spill; however, that risk is offset by the increased safety in the channel expected from the widening and deepening of the SNWW. LNG and pipeline projects presented in this analysis would implement water quality control measures (soil erosion prevention and control, spill prevention and response plans, and runoff containment).

4.16.5.2.5 Sediment Quality

None of the projects reviewed for this assessment are expected to impact sediment quality. For projects where contaminant spills or leaks are a potential adverse effect, prevention and response plans would be implemented. None of the sediment analyses conducted for this project identified cause for concern.

4.16.5.2.6 Shoreline/Bank Erosion

Shoreline fluctuations along the Gulf, natural waterways, and constructed navigation channels within the study area are ongoing. While some of the erosion and change can be attributed to natural causes, these can be exacerbated by unmitigated wave action, destabilized shoreline, loss of vegetation, and other factors. Such factors are generally a result of increased frequency and size of ship traffic (enhancing wave action), conversion of shallow gradual water – shoreline transition areas to deeper, open water, and upland activities and development, which can increase runoff and erosion. The Preferred Alternative is expected to reduce the number of vessel trips when compared to the number of trips expected with the No-Action Alternative, thus reducing the potential for increased wave action. Some of the habitat restoration projects reviewed are expected to decrease shoreline erosion in small, localized areas.

Additionally, beach and shoreline nourishment as part of projects' mitigation measures, slow the rate of erosion and shoreline loss in specific areas.

4.16.5.3 Cultural and Socioeconomic Resources

4.16.5.3.1 Economy

All of the channel enhancement, maintenance, LNG, and pipeline projects are expected to have a net benefit to the regional economy.

4.16.5.3.2 Recreational Facilities/Areas

Although some of the projects considered in this analysis create conditions that contribute to shoreline erosion, vegetation loss, and land use impacts throughout their project areas, many public recreation lands owned by the USFWS (Texas Point NWR, McFaddin NWR), TPWD (Tony Houseman WMA, J.D. Murphree WMA, units of the Lower Neches River WMA), TxDOT, and LDWF (Sabine Island WMA) benefit from many of the mitigation and minimization measures. Cumulative and coordinated wetland enhancement and restoration efforts on public lands, increased access to public waters, and habitat creation contribute to habitats, which support recreational activities (bird watching, hunting, fishing). The Preferred Alternative's DMMP restoration measures and marsh mitigation would result in a net benefit to those recreational areas by creating substantial marsh acreage.

4.16.5.3.3 Commercial and Recreational Fisheries

None of the projects reviewed would adversely impact commercial or recreational fisheries (see also subsection 4.16.5.1.6, Essential Fish Habitat). The Preferred Alternative DMMP and marsh mitigation measures would provide a long-term net benefit to fisheries by the creation of new nursery areas.

4.16.5.3.4 Ship Accidents/Spills

The LNG and pipeline projects, in combination with this project's Preferred Alternative, are expected to increase the number of large vessels using the area's navigable waterways (i.e., SNWW, GIWW, Neches River). It is anticipated that the deepening of the SNWW under the Preferred Alternative, in combination with the other dredging and port projects reviewed in this analysis, would have a net benefit on shipping safety; therefore, the potential for accidents and spills is likely to decrease.

4.16.5.3.5 Public Health and Safety

Most of the LNG and pipeline projects, in addition to this project, increase the potential for large ship traffic in inhabited areas along project area waterways. No adverse impacts are anticipated for these projects, although, small recreational craft traffic and other channel users may experience delays and reduced mobility with increases in ship traffic throughout the project area.

4.16.5.3.6 Cultural Resources

Activities associated with any of the reviewed projects have the potential to adversely affect unknown cultural resources by altering the integrity of the location, design, setting, materials, construction, or association contributing to a resource's significance (related to National Register eligibility criteria). No known sites on the NRHP would be impacted by projects reviewed in this analysis; however, projects that are eligible under NRHP criteria have been identified and could be affected. Discovery of potentially protected features/sites during construction and maintenance activities would require verification and further coordination with the SHPO.

4.16.6 Conclusions

Cumulative impacts from past, existing, and reasonably foreseeable future projects, along with the Preferred Alternative, are not expected to have significant adverse effects within the study area. Many of the projects within the study area are part of the continued port and shipping industry development. Some projects considered in this assessment are beneficial to certain natural resources (predominantly wetlands and the species dependent on them) and add to the diversity and health of publicly held recreation and conservation areas, migratory bird habitats, EFH, and other sensitive coastal resources. Impacts associated with the Preferred Alternative have been fully offset by compensatory mitigation measures. In addition, the Preferred Alternative would have net beneficial effects on wetlands, water quality, and SAV with the construction of extensive BU features on the Neches River and the Gulf shoreline.

5.0 MITIGATION PLAN

This chapter discusses the evaluation of mitigation measures for the Preferred Alternative, and presents the Recommended Mitigation Plan that has been developed in consultation with the appropriate resource agencies. Mitigation is necessary because unavoidable impacts to nationally significant intertidal wetlands remain after efforts to minimize impacts were exhausted. Net project impacts and benefits after application of DMMP BU feature benefits, are summarized in Table 5.1-1.

Table 5.1-1
Net Project Impacts and Benefits by Average Annual Habitat Units

	Bottomland Hardwood	Swamp	Fresh Marsh	Intermediate Marsh	Brackish Marsh	Saline Marsh	Totals
Preferred Alternative Impacts (negative AAHUs)							
Texas	0	–2	–6	–8	–31	–	–12
Louisiana	0	0	–8	–571	–3	–7	–709
Total Project Impacts	0	–2	–96	–619	–54	–2	–121
Preferred Alternative Benefits (positive AAHUs)							
Texas	0	0	284	433	235	222	1,068
Louisiana	0	0	0	0	0	210	210
Total Project Benefits	0	0	178	433	235	432	1,278
Net Project Benefits or Impacts (AAHUs)	0	–2	–6	–186	81	390	–43

This chapter is divided into six sections: Section 5.1 summarizes Federal policy and regulatory requirements for mitigation plans, and mitigation objectives that were followed in the plan's development. Section 5.2 provides a brief history of the development and coordination of the Recommended Mitigation Plan, including application of the HS and WVA models. Section 5.3 summarizes FWP impacts of the Preferred Alternative after benefits of the DMMP BU features have been applied. Section 5.4 discusses the evaluation of alternatives for compensatory mitigation, and presents the cost effective/incremental cost analysis (CE/ICA) of mitigation alternatives. Section 5.5 describes the Recommended Mitigation Plan that compensates for unavoidable salinity impacts.

5.1 SUMMARY OF PROJECT IMPACTS

Unavoidable indirect impacts of the Preferred Alternative in Louisiana remain after all benefits of the DMMP BU features have been applied. Although the SNWW channel is located primarily in Texas, large indirect impacts may occur due to small increases in salinity levels causing an increase in wetland loss and a decrease in biological productivity in aquatic habitats of both Texas and Louisiana. Remaining impacts in Louisiana may affect approximately 182,000 acres (284 square miles) of tidal, emergent marsh habitats, resulting in a total loss of 1,709 AAHUs (a 1.8 percent loss from the FWOP condition). The important ecological functions of the wetlands in the affected area would decline as increases in salinity levels affect marsh communities, and the fish and wildlife that depend upon this habitat. The slightly higher salinities may lead to the loss of 691 acres of marsh, associated SAV and shallow-water habitat, as stressed emergent marsh converts to open water. Some direct effects of the Preferred Alternative's navigation improvements were not captured and quantified by the WVA modeling. However, a full impact analysis has been performed for these effects, and they have been determined to be minor and temporary. These impacts include (1) impacts to water quality and benthic organisms and their Gulf, estuarine, and riverine water-bottom habitats resulting from dredging to construct the navigation improvements, the creation of new offshore ODMDSs, the borrow area trench for Willow Bayou mitigation areas, and marsh restoration in shallow, open-water areas; (2) potential dredging impacts to bottom-feeding and pelagic organisms such as sea turtles; and (3) potential impacts to shoreline birds and their habitat from the placement of maintenance material on the Gulf shoreline.

Potential adverse affects to threatened and endangered sea turtles during hopper dredging to construct the Entrance Channel would be addressed by the adoption of reasonable and prudent measures to avoid impacts that are established in the BO for the CIP. No other adverse effects to threatened and endangered species have been identified.

5.2 MITIGATION PLANNING

In the evaluation of alternatives for the SNWW CIP, ecological impacts of the Preferred Alternative have been avoided and minimized to the greatest extent practicable, as required by national policy (Section 906(d), WRDA 86), national environmental laws and executive orders, and the USACE regulations (ER 1105-2-100). The results of proposed actions to minimize impacts are presented in detail in Chapter 2. Unavoidable impacts to significant resources that remain are compensated to the extent justified as described below.

5.2.1 Compliance with Federal Requirements

Implementation guidance for Section 2036(a) of WRDA 07 (Mitigation for Fish and Wildlife and Wetlands Losses), issued August 31, 2009, requires that the Preferred Alternative contain a specific plan to mitigate fish and wildlife losses since it has been determined that the Preferred Alternative would have unavoidable impacts after benefits of the DMMP BU features are applied. Adverse impacts to ecological resources that are caused by a proposed project must be avoided or minimized to the extent practicable, and remaining unavoidable impacts must be compensated to the extent justified. The Preferred Alternative must contain sufficient mitigation to ensure that the CIP would not have more than a negligible adverse impact on significant ecological resources.

Central to this requirement is the determination of significance, as mitigation is required only for impacts to significant resources. Significance must be based upon the contribution of the resource to the Nation's economy and technical, institutional, and/or public recognition of the value of the resource. Criteria for determining significance include, but are not limited to, scarcity or uniqueness of the resource from a national, regional, State, or local perspective. The USFWS Habitat Stewardship Program has identified estuarine intertidal emergent wetlands as one of three nationally recognized "scarce and vulnerable" wetland habitats. These are the same sensitive wetland habitats (saline, brackish, intermediate, and fresh marsh) addressed by the Mitigation Plan.

These habitats are also considered significant and vulnerable by the CWPPRA, Public Law 101-646 (Title III) and the North American Waterfowl Management Plan (2004). The Texas Land and Water Resources Conservation Plan (TPWD, 2005e) recognizes the Gulf coastal marshes in Tier One of high priority ecoregions and considers these habitats to be the most threatened of the State's two high diversity ecoregions. Significant marsh habitat on the Lower Neches River and along the Texas Point shoreline have been declared "critical erosion areas" by the Texas Coastwide Erosion Response Plan. Furthermore, coastal marshes in the Louisiana portion of the study area are recognized as threatened and vulnerable by the Louisiana Coast 2050 Plan (LCWCR/WCRA, 1998), the LCA Ecosystem Restoration Study (USACE, 2004a), and the Louisiana Comprehensive Master Plan (LCPRA, 2007; USACE, 2008a).

Although mitigation technically includes avoiding and minimizing project impacts to ecological resources, this chapter focuses on actions that are typically considered compensatory mitigation, i.e., rectifying impacts by restoration, preservation, or maintenance activities during the life of the project, or replacing fish and wildlife resources that have been adversely affected. Replacements are generally made "in-kind," but substitutions, or replacements "out-of-kind," are also acceptable mitigation if they are at least equal in value and significance to the resources lost. The purchase of credits from mitigation banks established by others was considered as an option in providing compensatory mitigation for the Preferred Alternative. Only two existing mitigation banks were identified in the lower Sabine and Neches watersheds. Neither was available for use as the credits from one were sold out and the other was developed for the exclusive use of a State agency.

The WVA model (Appendix C) quantifies impacts to all habitats in the study area and provides a means to establish the appropriate amount of compensating mitigation. Recommended mitigation measures must be justified by CE/ICA, which identifies the least-cost mitigation plan by demonstrating that the value of the last increment of losses prevented, reduced, or replaced is at least equal to the costs of the last added increment.

The USACE regulations (ER 1105-2-100) recognize wetland resources for special consideration in mitigation planning, and these are the type of resources that could suffer long-term impacts from the Preferred Alternative. Impacts to wetlands must be fully mitigated, and projects must meet the goal of no net loss of wetlands. The Mitigation Plan described below fulfills the special requirements for wetlands. These plans also contribute to multiagency regional plans (Louisiana Coast 2050; a TPWD regional management plan for J.D. Murphree WMA, Sea Rim State Park, Texas Point, and McFaddin NWR; and the North American Waterfowl Plan) by restoring and preserving scarce and vulnerable wetlands and wildlife habitat, and using dredged material beneficially to the greatest extent possible.

5.2.2 Compensatory Mitigation Objectives and Target

The following objectives were established to evaluate mitigation measures considered for the SNWW CIP. The objectives were developed by the USACE in consultation with the ICT.

- Minimize salinity impacts to the SNWW affected area
- Maximize the use of dredged material in marsh restoration measures
- Meet goal of no net loss of wetlands
- Replace lost habitat quality on a one-to-one basis as measured by AAHUs
- Replace habitats in-kind to the extent practicable
- Mitigate losses in the state where they occur
- Share dredged material from Sabine Pass equally between Louisiana and Texas

These objectives reflected the most significant expected impacts of the CIP, widespread interest in potential beneficial uses of dredged material, the national policy objective to prevent wetland loss, and the USACE requirements to fully compensate for unavoidable project adverse effects. The last objective is related to the fact that the CIP affects resources from two states. While this FEIS evaluates impacts on the SNWW coastal and estuarine system without regard to state boundaries, the mitigation plan complies, to the greatest extent practicable, with the CZMP for each state. Under the Coastal Zone Management Act (CZMA), states with approved coastal management programs have jurisdiction within their coastal boundaries to ensure compliance with their programs. The CZMA and its implementing regulations require that Federal activities comply to the maximum extent practicable with these programs. In Louisiana, the Louisiana State and Local Coastal Resources Management Act functions as the state coastal management program for CZMA purposes. Compensatory mitigation is used to offset any net loss of wetland ecological value after efforts have been made to avoid or minimize impacts. Furthermore, the CWPPRA requires Federal agencies to ensure that maintenance or modification of navigation projects be consistent with the purposes of the restoration plan submitted under CWPPRA. Louisiana has adopted a Coastal Wetlands Conservation Plan under this authority with a goal of no net loss of wetlands in coastal areas of Louisiana as a result of development activities. The proposed SNWW mitigation plan would provide additional compensatory mitigation beyond the total project loss of 843 AAHUs so that impacts in Louisiana would be compensated in that state. There is, however, a significant exception to this requirement. Federal lands are excluded from coverage under the CZMA, and this means that compensatory mitigation for impacts to Federal lands may be developed without regard to state boundaries.

Since the CZMA does not apply to Federal lands, excess Texas BU benefits could be used to compensate for impacts to Federal lands in Louisiana. The only lands affected by this exclusion are located in the Sabine NWR. While the Texas Point and McFaddin NWRs in Texas would also be affected by salinity increases associated with the project, two DMMP BU features (the Neches River and the Gulf Shore BU features) provide benefits that offset all project impacts in Texas (including impacts to both NWRs) and provide excess benefits of 656 AAHUs. The DMMP BU features fulfill Texas's CZMP requirements to avoid and minimize impacts to the coastal zone, such that no compensatory mitigation for Texas state resources is needed.

Total SNWW project impacts to the Sabine NWR are –340 AAHUs. When these are removed from the total project impacts in Louisiana (–1,499 AAHUs), the mitigation target proposed for compliance with Louisiana's CZMP is –1,159 AAHUs. Table 5.1-2 illustrates this calculation. Since all mitigation measures for the SNWW would be located in Louisiana, the new mitigation target would compensate for total project losses of –843 AAHUs by providing 1,159 AAHUs of compensatory mitigation.

Table 5.1-2
FWP Compensatory Mitigation Target for Louisiana

Units (AAHUs)	Texas	Louisiana	Project
Net FWP Benefits/Impacts			
Total Impacts (negative)	–12	–709	–121
Total BU Benefits (positive)	1,068	210	1,278
Net FWP Benefits (positive) or Impacts (negative)	656	–499	–43
Excess Texas Benefits Applied to Federal Lands (Louisiana)			
Excess Texas Benefits	656		
Sabine National Wildlife Refuge Impacts	–40		
Net Excess Texas Benefits	316		
Compensatory Mitigation Target			
Net Impacts by State and Project		–499	–43
Federal Impacts Compensated with Texas Excess Benefits		340	
FWP Compensatory Mitigation Target		–159	–43

5.3 RESOURCE AGENCY COORDINATION OF THE RECOMMENDED MITIGATION PLAN

Since the primary environmental concerns are the interrelated issues of saltwater intrusion, marsh loss, and destruction of wildlife habitat and fishery nursery areas, the ICT formed two workgroups to oversee the development and application of models used to evaluate salinity changes and ecological effects of the CIP. The MW participated in the development and review of the HS model, and the HW participated in the selection and application of the ecological model. Both models played an integral role in the development of FWOP and FWP conditions and were used to compare the effectiveness of restoration and mitigation measures.

Any ICT agency interested in participating was invited to attend these workshop meetings. Representatives from the following agencies participated in one or both of the workgroups:

- USFWS Clear Lake (Texas) Field Office
- USFWS – Louisiana Field Office
- USFWS – Chenier Plain NWR complex
- USFWS – Sabine NWR

- NMFS – Galveston, Texas
- NMFS – Baton Rouge, Louisiana
- EPA Region 6
- GLO
- TWDB
- TPWD
- TPWD – J.D. Murphree WMA
- LDNR
- LDWF
- SRA-TX
- USACE (Galveston District and ERDC-CHL)

Concerns that a deeper navigation channel would bring higher salinity in the Sabine Lake estuarine system were addressed with a 3-dimensional HS model that predicts changes in salinity, circulation, and water elevation due to proposed channel improvements. The modeling was performed by the ERDC's CHL worked closely with the MW to calibrate and verify the base model for initial modeling. The modeling was revised in 2009 to incorporate changes resulting from external and USACE reviews. The MW reviewed the ERDC's model calibration and verification process, and the revised modeling results.

The SNWW ICT established the HW to apply the WVA model; representatives from 14 agencies regularly attended and agreed upon data used as inputs for the model. Over 30 ICT and workgroup meetings were conducted from 2001 to 2006, and one meeting was held in 2009. The USFWS-Louisiana Ecological Field Office provided assistance to ensure that WVA methodology (USFWS, 2002b) was followed properly and that WVA model Excel worksheets were being used appropriately. The USACE conducted an in-house quality check for worksheet accuracy. In 2009, changes in the proposed project and HS modeling necessitated that the WVA modeling be revised. Due to schedule constraints, the USACE performed the modeling without ICT involvement, basing it as closely as possible on methods and assumptions used by the ICT in the original modeling. The results of this remodeling were coordinated with the ICT. A quality check was also performed for the revised worksheets.

5.4 EVALUATION OF ECOLOGICAL MITIGATION MEASURES

5.4.1 Preliminary Screening of Alternatives

A large number of potential mitigation measures were evaluated, but the majority were eliminated during preliminary screening. Measures were generally of two types: measures to reduce or avoid salinity intrusion and measures to restore or protect habitat. Salinity effects for large-scale measures affecting the estuary as a whole were evaluated with the HS model; a desktop model was developed for alternatives affecting smaller, localized drainages (Brown and Stokes, 2009). Ecological benefits were evaluated for most of the measures using the WVA model; some were eliminated early in the process because they were not feasible or implementable. Screening-level costs were based upon conceptual designs and costs for similar structures that had been constructed recently by the USFWS. Final costs were only developed for mitigation measures ultimately included in the Mitigation Plan.

5.4.1.1 Measures to Reduce Salinity Intrusion

Since impacts of the Preferred Alternative would be related primarily to salinity increases associated with a deeper SNWW navigation channel, extensive efforts were made to identify mitigation measures that could minimize or eliminate the projected increase in salinity intrusion. Measures were formulated that affected the estuary as a whole, or smaller, localized areas within specific wetlands.

Sabine Pass Lock and Dam

The construction of a lock and dam at Sabine Pass was considered to address increases in saltwater intrusion from the proposed deepening and widening of the SNWW. The lock and dam were not considered to be a project alternative because the structures would not improve navigation efficiency, but it was believed they could minimize salinity impacts. The existing SNWW navigation channel through Sabine Pass is 40 feet deep and 500 feet wide. Large ocean-going petroleum and chemical product tankers regularly transit the waterway. Placing a lock in the channel would create new transit delays as discussed below.

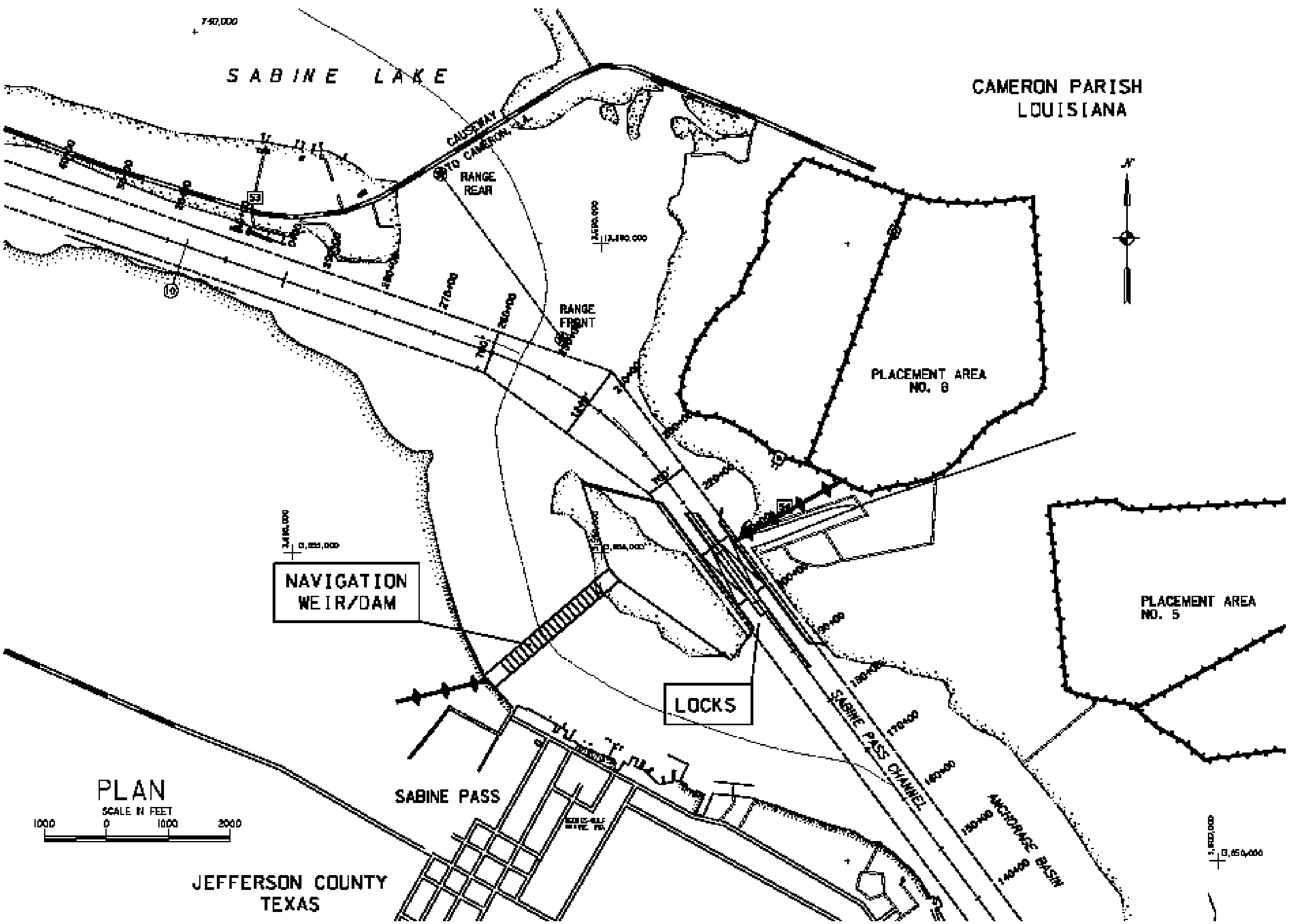
The structures anticipated for salinity control would consist of two navigation locks within the current SNWW navigation channel. Figure 5.4-1 presents a conceptual drawing of the lock and dam alternative. A connecting levee would be required from the east lock wall to the Louisiana side of the pass, and a dam would be required to close the old river channel on the Texas side. This dam would be constructed from the cutoff island to the Texas shoreline immediately upstream of the City of Sabine Pass. It would consist of a reinforced concrete sill positioned at elevation –25 feet mean low tide (MLT), with a set of tainter gates. The tainter gates would be closed under normal conditions, but would open to allow the discharge of upstream floodwaters. A levee would also be required to connect the west end of the dam to higher ground.

The lock and dam would prevent continuous saltwater intrusion from the Gulf by blocking the deeper navigation channel and old river channel, while allowing two-way ship traffic and periodic discharges of upstream floodwaters. The lock and dam structure would create a pool behind the structures with a 3- to 5-foot increase in water elevations over current conditions. The pool is necessary to create the hydraulic head pressures required for the lock to function properly.

There are significant engineering challenges to be met in designing the large locks required to accommodate the large ships, which would use the proposed CIP. The width and depth of the lock chamber would be larger than any other known lock constructed in the U.S., and therefore additional research and data would be needed in order to design and construct the large lock gates and machinery.

FIGURE 5.4-1

CONCEPTUAL DESIGN OF LOCK-DAM STRUCTURE



With respect to impacts on navigation, the locks would not have a direct effect on the deepening benefits of the proposed project, but would significantly reduce the navigational efficiency of the existing or proposed channel. A preliminary economic analysis estimated that annual delay costs for both inbound and outbound trips would be approximately $7 million. This estimate did not include queuing effects. In reality, slowdowns due to the locks would generate additional delays and queues would form. The vessel delay and personnel cost would need to be treated as added costs for the lock feature. The delays associated with a lock would lead to additional cost and result in a loss of business for the ports of Port Arthur and Beaumont.

From an environmental standpoint, the proposed lock and dam would have both positive and negative environmental impacts on the region. On the positive side, the lock would significantly reduce saltwater intrusion through Sabine Pass into the upriver wetlands systems. Such reduction in saltwater intrusion would ameliorate degradation caused by current saltwater intrusion and permit slow reestablishment of some of the former fluvial freshwater wetlands that existed prior to initial channelization of the river. These freshwater wetlands would likely support increased freshwater sports fishing opportunities, waterfowl, and perhaps some cypress-tupelo swamp acreage.

However, the proposed lock and dam would produce negative environmental impacts as well. Reducing saltwater inputs upstream and flooding existing marshes would significantly decrease productivity of the existing saline and brackish marshes, as the obligate higher-salinity marsh plants are gradually lost in the freshwater conditions. In addition, even before significant loss of marshes upstream of the lock, many largely marine species would be physically precluded from reaching the nursery marsh areas by the lock. Therefore, many commercial, sportfish, and shellfish species would likely decrease in abundance.

The lock alternative was eliminated from further consideration on the basis of navigation economics, environmental, and cost factors. The lock alternative would reduce navigation benefits and result in higher vessel transportation costs. Environmental benefits associated with control salinity intrusion would be partially offset by significant impacts associated with restricting ingress/egress of marine organisms. Finally, significant engineering challenges associated with construction of such a large structure would result in high costs, estimated in excess of $2 billion.

Sabine Lake Sill

Three versions of a sill or weir at the mouth of Sabine Lake were modeled with the HS model (Brown and Stokes, 2009): a submerged sill at –10 feet MLT; a stepped, submerged sill ranging from –2.5 feet MLT at the shore to a –10-foot MLT boat bay in the center; and an emergent sill with a –10-foot MLT boat bay in the center of the channel. This alternative was eliminated from further consideration when modeling determined that a sill provided little, if any, salinity mitigation, except for some reduction in salinity at the southwest end of Sabine Lake. This is likely because the principal pathway for salinity transport into the system is via the Sabine-Neches Canal at the northwest corner of Sabine Lake. In addition, the more restrictive versions created unacceptably high velocities through the mouth of Sabine Lake and unacceptably high water elevations in the southern part of Sabine Lake during flood events.

Structural Water Control

Nineteen various water-control structures were proposed to control salinity intrusion into the marshes east of Sabine Lake and west of Sabine Pass (see Appendix C). The ERDC developed desktop models to evaluate changes in salinity achieved by these structures (Brown and Stokes, 2009), and the WVA model was applied to evaluate their ecological benefits. Various combinations of a sheet pile wall, a large rock weir, earthen plugs, and channel fill were evaluated for Texas Bayou in the Texas Point NWR. Large, adjustable salinity control structures and large rock weirs were evaluated for Willow Bayou, Three Bayou, Black Bayou, Greens Bayou, and the Right Prong of Black Bayou. Smaller rock weirs and low rock liners were assessed for numerous smaller channels in the Willow Bayou and Black Bayou hydro-units. Earthen plugs in logging canals and submerged pipeline ROWs were suggested as a means of reducing salinities within swamps at Blue Elbow and the Sabine Island WMA. NMFS was concerned that proposed water control structures could adversely affect EFH and other aquatic resources by blocking or reducing marine fishery access to the Louisiana marshes east of Sabine Lake. It is possible that structures could cause salinities to be higher in managed areas during droughts or after storm surges. Ultimately, all of the proposed water control structures were eliminated from further consideration when WVA modeling yielded net negative benefits (i.e., impacts). Salinity reductions were generally modest and could not overcome the adverse effects of restrictions to marine organism access.

Ensuring Freshwater Inflow

Purchasing freshwater flows from both the SRA-TX and LNVA was investigated as a potential mitigation measure. Contracts could be negotiated for the 50-year period of analysis that require annual payments for a specific volume of flow, which was determined with the HS model. The alternative was eliminated from further consideration because there is no guarantee that the mitigation flow would be available when it is needed most—during periods of low flows or drought, when the incremental salinity increase associated with the deeper navigation channel would have its greatest adverse effect. The new allocation would be subordinate to preexisting water rights and subject to changes in priorities by State water plans. Ultimately, there is no guarantee that sufficient flows, although contracted and paid for annually, would be provided at the expense of human needs.

Marsh Creation

Several measures were considered in which marshes would be used to constrict flows and thereby reduce salinity intrusion from the navigation channel. Marsh creation was evaluated for the following locations: (1) upstream and downstream of the mouth of Sabine Lake, (2) a specific shoreline reach of the Port Arthur Canal, (3) an eroded area at the head of the west jetty, (4) eroding islands between the Sabine-Neches Canal and the northwest corner of Sabine Lake, and (5) the mouths of channels draining Rose City and Bessie Heights. Some of these alternatives were eliminated from further consideration when HS modeling determined they were not effective at reducing salinities. Others were eliminated because they would block access to private property, cause backwater flooding, or create safety problems with navigation.

5.4.1.2 Measures to Restore or Protect Habitat

The HW also evaluated a wide array of measures, which utilized marsh restoration, inshore shoreline protection, and Gulf shore nourishment to compensate for wetland loss or protect from increased erosion. The most effective of these in terms of costs and ecosystem benefits were ultimately selected for inclusion in the Recommended Mitigation Plan; those described below were eliminated during preliminary screening.

Marsh Restoration Measures

Thirty-nine combinations of measures and scales of marsh restoration were evaluated. Screening was based upon an informal analysis of benefits determined by the WVA model and costs developed by the USACE. All possible sources of material for marsh restoration were considered (submerged in situ soils, new work and maintenance material from the nearest SNWW channel reaches, sediments from Sabine Lake, Sabine River Channel maintenance material, and accumulated material in the Lake Charles Deepwater Channel/Louisiana GIWW). Locations evaluated for restoration were (1) a degraded marsh area near the head of the West Jetty in the Texas Point NWR; (2) Old River Cove east of the power plant intake canal; (3) the eastern shores of PAs 8 and 11 on Pleasure Island; (4) an old logging canal north of Texas Bayou; (5) a large open-water area south of the Louisiana GIWW and east of Black Bayou Cutoff; and (6) a small, confined open-water area at the northeast corner of the Louisiana GIWW and Black Bayou Cutoff. The large open-water area on the GIWW east of the Black Bayou Cutoff was eliminated because the area was approved for an in situ marsh-terracing project under CWPPRA Project CS-27. Different scales of marsh fill and source material were used within the same footprints in Willow and Black bayous to create different alternatives. Most of the alternatives were eliminated because they produced unacceptably low benefits when compared to costs. Small scales of in situ marsh terracing and marsh creation using dredged material located in the Willow and Black bayou hydro-units were eliminated because of low benefits. Twelve larger scales of the same alternatives were advanced for further screening due to their higher benefits and improved cost effectiveness.

Inshore Shoreline Protection

Twenty-one combinations of shoreline protection measures and scales were evaluated in the preliminary screening. Measures were developed for two locations: the eastern shore of Sabine Lake and the north shore of the GIWW in Texas.

For the GIWW shoreline, two separate reaches of rock breakwater (2.4 miles long and 1.5 miles long) were proposed to stabilize areas where low banklines allow higher-salinity waters from the GIWW to enter the large expanse of fresh and intermediate marsh north of the GIWW. Benefits were assessed using the WVA model, based upon an assumed salinity reduction in the marshes protected by the breakwater. The alternative was eliminated because of low benefits in relation to cost. IWR-PLAN comparison revealed it was less cost effective than other alternatives.

For the Sabine Lake shoreline, a foreshore dike was proposed for the Sabine Lake shore between Willow Bayou and the mouth of Black Bayou. This alternative was evaluated in three scales of 3, 4.4, and 8.6 miles in length. Two material types were evaluated for the breakwater: barged-in rock and earthen material obtained from Sabine Lake sediments adjacent to the breakwater. Each of these alternatives was also evaluated at three distances from the Sabine Lake shore: 150, 250, and 500 feet. Finally, marsh restoration behind the dikes was also proposed. Marsh would be created behind the earthen and rock alternatives, 150 feet from the shore using Sabine Lake sediments from the access channel required for construction, and new work material from the SNWW channel was evaluated for the 250- and 500-foot scales. Benefits determined by the WVA were based on the creation of new marsh and the elimination of shoreline retreat. Initially, the rate of shoreline retreat was determined by a GIS analysis of satellite images by the USFWS (Greco and Clark, 2005). However, the rate of shoreline retreat was later revised to incorporate the most likely rate of RSLR, and a forecasted 1.1-foot rise in water surface elevation. Costs of the different measures were estimated by the USACE, including additional costs to raise the dike to accommodate RSLR. All of these alternatives were eliminated because costs were high when compared to benefits.

Gulf Shore Nourishment

Eleven measures and scales of Gulf shoreline nourishment were evaluated for Texas and Louisiana Points. The measures were developed in an effort to find the most-cost-effective combination of pumping distance, material type, and length of shoreline nourishment. All of the alternatives were constrained by the requirement that both new work and maintenance material be split evenly between Texas and Louisiana. All but one assumed unconfined placement of dredged material along the current shoreline using a hydraulic pipeline dredge. One alternative envisioned construction of a confined cell along the Texas Point shoreline using new work and maintenance materials. This alternative was eliminated early in the screening because of excessively high costs. Alternatives relying upon unconfined placement of either new work or maintenance material from Sabine Pass sections 5 or 5 and 6 were evaluated for ½-, 2-, and 3-mile-long shoreline reaches. All would begin ½ mile from each jetty, avoiding areas near the jetties where the accretion rate is high. Cost effectiveness analysis determined that the 3-mile-long scale of the maintenance material alternative was the least-cost alternative for the placement of dredged material, and therefore it was adopted as part of the DMMP. One alternative that uses new work material to nourish shoreline at Louisiana Point was advanced for further screening as a potential mitigation alternative.

5.4.2 Final Screening of Ecological Mitigation Measures

The Mitigation Plan was selected using the USACE certified version of IWR-PLAN software. IWR-PLAN uses the tools of CE/ICA to weigh the costs of mitigation plans against their nonmonetary output. A mitigation plan is defined as a group of mitigation measures. Cost-effectiveness analysis is used to identify least-cost plans, and incremental cost analysis identifies the subset of cost-effective plans that are superior financial investments, called "best buys plans." Best buys plans are the most efficient plans at producing the output variable (in this case, AAHUs); they provide the greatest increase in the value of the output variable for the least increase in cost.

Mitigation measures advanced for final screening with IWR-PLAN are listed in Table 5.4-1. For the CE/ICA, the measures were expressed as Solutions A through M, and each solution was evaluated at different scales (Table 5.4-2). Two categories of solutions were evaluated:

1) Marsh restoration in the Willow and Black bayou areas; and
2) Gulf shore nourishment.

The footprint of several marsh restoration solutions is identical; they propose marsh restoration in the same physical area using different sources of sediment (i.e., in situ material, SNWW new work material, and dedicated dredging from Sabine Lake). Solutions with identical footprints are not combinable with other solutions and were identified as such in IWR-PLAN. Other solutions reflect different placement sequences and combinations for the various open-water locales within Willow Bayou or Black Bayou. These were developed in an effort to identify combinations that have more-cost-effective pumping distances. One alternative (LA 2-18C) was duplicated in the IWR-PLAN solutions, with the cost for dredging varied by the size of dredge (i.e., an average size dredge versus the largest, most powerful dredge that could access the area, the *California*). Scales are defined by adding increments of acreage restored, varying the amount of sediment used in the restoration, or the length of shoreline protected or nourished.

Table 5.4-2 contains incremental costs and output for all solutions and scales included in the analysis. The IWR-PLAN code for each solution and the scales of that solution are indicated in the first column, and a brief description of each solution is provided in the second column. For example, the first solution is Willow Bayou in situ terracing (Solution A). This solution has four scales (A_1-A_4), which increase in acres incrementally through the four scales. Scale A_1 restores 38 acres of emergent marsh; Scale A_2 creates an additional 26 acres for a cumulative total of 47 acres for both scales A_1 and A_2. The third column provides a unique identification number for each solution and scale that was used for mapping and tracking through cost estimating and ecological modeling. The fourth column provides the cumulative AAHU output associated with the cumulative acres being restored, and the fifth provides the cumulative average annualized cost.

Variables used in the analysis were nonmonetary ecological benefits established by WVA modeling (expressed in AAHUs) and average annualized costs. These costs include the first cost of construction, costs for marsh plantings, postconstruction monitoring, and 50-year annualized O&M costs. The costs of alternatives that involve the use of maintenance material over one or multiple dredging cycles were amortized over the 50-year period of analysis, using dredging-cycle projections based on historical dredging data and the discount rate in effect at that time.

Table 5.4-1
Mitigation Alternatives Evaluated in Final Screening

Marsh Restoration - In Situ Terracing			
Description of Alternative			
"Duck-wing"-shaped earthen terraces built with in situ material using amphibious excavator. Each terrace is 1,000 feet long; 100-foot gap between terraces; approximately 500 feet between each row of terraces. Terraces should have 15-foot-wide tops at +2.0 feet NAVD88 and 4:1 side slopes.			
Hydro-Unit	No.	Size of Influence Area	Emergent Marsh Created
Willow Bayou	LA 2-16(A)	Influence area – 1,831 acres in north part of Greens Lake; located within the same footprint as LA 2-16(B) and LA 2-16(C)	38 acres
	LA 2-17(A)	Influence area – 2,297 acres in southern part of Greens Lake; located within the same footprint as LA 2-17(B) and LA 2-17(C)	45 acres
	LA 2-18(A)	Influence area – 680 acres in area north of Willow Bayou canal; located within the same footprint as LA 2-18(B) and LA 2-18(C)	11 acres
	LA 2-19(A)	Influence area – 1,809 acres in area west of Deep Bayou; located within the same footprint as LA 2-19(B) and LA 2-19(C)	28 acres
Marsh Restoration – Sabine Lake Dedicated Dredging			
Description of Alternative			
Hydraulically dredged material from Sabine Lake (dedicated dredging) to restore marsh and shallow-water habitat in open-water areas of marsh. Borrow trench located 500 feet from shore, excavated approximately 7.5 feet deep; width and length vary for each scale. Assume unconfined flow of maintenance material, frequent movement of pipe, and few training or containment structures.			
Hydro-Unit	No.	Size of Influence Area	Emergent Marsh Created
Willow Bayou	LA 2-16(B)	Influence area – 1,831 acres in north part of Greens Lake; borrow trench approximately 1,000 feet wide x 2 miles long	822 acres
	LA 2-17(B)	Influence area – 2,297 acres in southern part of Greens Lake area; borrow trench approximately 1,250 feet wide x 2 miles long	1,035 acres
	LA 2-18(B)	Influence area – 680 acres in area north of Willow Bayou Canal; borrow trench approximately 700 feet wide x 0.8 mile long	251 acres
	LA 2-19(B)	Influence area – 1,809 acres in area west of Deep Bayou; borrow trench approximately 1,200 feet wide x 1.8 miles long	719 acres
	LA 2 ADD B	Influence area – 1,285 acres in area north of Willow Bayou Canal; borrow trench approximately 1,000 feet wide x 1.25 miles long	436 acres

Table 5.4-1, cont'd

Marsh Restoration – SNWW New Work Material			
Description of Alternative			
Use new work material from SNWW Section 10 to restore emergent marsh and shallow-water habitat in open water in north part of Greens Lake area. Assume unconfined flow of new work material, frequent movement of pipe, and few training or containment structures.			
Hydro-Unit	No.	Size of Influence Area	Emergent Marsh Created
Willow Bayou	LA 2-16(C)	Influence area – 1,831 acres in north part of Greens Lake area; located within the same footprint as LA 2-16(A) and LA 2-16(B)	822 acres
	LA 2-17(C)	Influence area – 2,297 acres in southern part of Greens Lake area; located within the same footprint as LA 2-17(A) and LA 2-17(B)	1,035 acres
	LA 2-18(C)	Influence area – 680 acres in area north of Willow Bayou Canal; located within the same footprint as LA 2-18(A) and LA 2-18(B)	251 acres
	LA 2-19(C)	Influence area – 1,809 acres in area west of Deep Bayou; located within the same footprint as LA 2-19(A) and LA 2-19(B)	719 acres
	LA 2-ADD C	Influence area – 1,285 acres in area north of Willow Bayou Canal; located within the same footprint as LA 2-ADD B	436 acres
Marsh Restoration – Channel to Orange Maintenance Material			
Description of Alternative			
Hydraulically pump maintenance material from the Channel to Orange (Sabine River) between East Pass and the GIWW into areas north of Black Bayou to restore emergent marsh in degraded marsh and open-water areas. Assume unconfined flow of maintenance material, frequent movement of pipe, and few training or containment structures. Material would come from maintenance dredging of the Sabine River Channel.			
Hydro-Unit	No.	Size of Influence Area	Emergent Marsh Created
Black Bayou	LA 3-10R	Influence area – 2,465 acres; restoring 132 acres every 5 years, TY 5 thru TY 30 (total of 6 cycles, ending TY 30)	792 acres

Table 5.4-1, cont'd

Marsh Restoration - GIWW Dedicated Dredging			
Description of Alternative			
Dedicated dredging of adjacent GIWW to restore emergent marsh and shallow-water habitat; percent of open water restored to emergent marsh is different in A and B scales. Assume unconfined flow of hydraulically pumped material that has accumulated in GIWW (formerly the 30-foot Deepwater Channel to Lake Charles), frequent movement of pipe, and few training or containment structures.			
Hydro-Unit	No.	Size of Influence Area	Emergent Marsh Created
Black Bayou	LA 3-15(A)	Influence area – 1,788 acres in area west of Black Bayou Cutoff Canal; assume 60 percent of open water restored to emergent marsh	546 acres
	LA 3-18(A)	Influence area – 1,877 acres in large area of open water south of LA 3-15; assume 60 percent of open water restored to emergent marsh	497 acres
	LA 3-15(B)	Influence area – 1,788 acres area west of Black Bayou Cutoff Canal; assume 75 percent of open water restored to emergent marsh	683 acres
	LA 3-18(B)	Influence area – 1,877 acres in large area of open water south of LA 3-15; assume 75 percent of open water restored to emergent marsh	621 acres
Gulf Shoreline Nourishment			
Description of Alternative			
Nourish Gulf shoreline at Louisiana Point; length of nourished shore and number of placement cycles vary. Material pumped along shoreline using hydraulic pipeline dredge. Assume 50:50 split of material between Texas and Louisiana. Assume 60 percent retention of material after initial placement; 50 percent of newly added acres remain at end of 6 years.			
Hydro-Unit	No.	Size of Influence Area	Length of Shoreline
Sabine Lake Ridges	LA 5-3	Nourish 0.5 to 1.0 mile from east jetty; assume one-time unconfined placement of new work material from SNWW Section 5; all added acres eroded away by TY 51	0.5 mile
	LA 5-1 and 6-1	Nourish 0.5 to 3.5 miles from east jetty; assume one-time unconfined placement of new work material from SNWW Section 5; all added acres eroded away by TY 51	3.0 miles
	LA 5-5	Nourish 0.5 to 3.5 miles from east jetty; assume one-time unconfined placement of new work material from SNWW sections 5 and 6; all added acres eroded away by TY 51	3.0 miles

Table 5.4-2
Solutions and Scales for Cost Effectiveness/Incremental Cost Analysis

	Solutions	ID#	Cumulative AAHUs per Solution and Increment	Cumulative Average Annual Cost ($) per Solution and Increment
Marsh Restoration				
A_1	Willow Bayou In Situ Terracing (38 acres)	LA 2-16A	18	145,413
A_2	Willow Bayou In Situ Terracing (83 acres)	LA 2-16A LA 2-17A	40	316,720
A_3	Willow Bayou In Situ Terracing (111 acres)	LA 2-16A LA 2-17A LA 2-19A	54	426,845
A_4	Willow Bayou In Situ Terracing (122 acres)	LA 2-16A LA 2-17A LA 2-19A LA 2-18A	59	472,395
B_1	Willow Bayou Sabine Lake Dedicated Dredging (822 acres)	LA 2-16B	446	2,794,551
B_2	Willow Bayou Sabine Lake Dedicated Dredging (1,857 acres)	LA 2-16B LA 2-17B	940	5,980,573
B_3	Willow Bayou Sabine Lake Dedicated Dredging (2,576 acres)	LA 2-16B LA 2-17B LA 2-19B	1,360	8,183,098
B_4	Willow Bayou Sabine Lake Dedicated Dredging (2,827 acres)	LA 2-16B LA 2-17B LA 2-19B LA 2-18B	1,512	8,806,642
C_1	Willow Bayou Sabine Lake Dedicated Dredging (822 acres)	LA 2-16B	446	2,794,551
C_2	Willow Bayou Sabine Lake Dedicated Dredging (1,857 acres)	LA 2-16B LA 2-17B	940	5,980,573
D_1	Willow Bayou Sabine Lake Dedicated Dredging (251 acres)	LA 2-18B	152	620,877
D_2	**Willow Bayou Sabine Lake Dedicated Dredging (687 acres)**	**LA 2-18B LA 2-ADD B**	**365**	**1,632,476**
D_3	Willow Bayou Sabine Lake Dedicated Dredging (1,406 acres)	LA 2-18B LA 2-ADD B LA 2-19B	785	3,945,394
E_1	Willow Bayou SNWW New Work using the Dredge *California* (2,827 acres)	LA 2-16C LA 2-17C LA 2-19C LA 2-18C	1,552	9,205,547
F_1	Willow Bayou SNWW New Work (822 acres)	LA 2-16C	446	3,692,959
F_2	Willow Bayou SNWW New Work (1,857 acres)	LA 2-16C LA 2-17C	940	7,399,625

Table 5.4-2, cont'd

	Solutions	ID#	Cumulative AAHUs per Solution and Increment	Cumulative Average Annual Cost ($) per Solution and Increment ($1,000)
G_1	Willow Bayou SNWW New Work (251 acres)	LA 2-18C	152	1,391,853
G_2	Willow Bayou SNWW New Work (687 acres)	LA 2-18C LA 2-ADD C	365	3,010,940
G_3	Willow Bayou SNWW New Work (1,406 acres)	LA 2-18C LA 2-ADD C LA 2-19C	785	6,336,854
H_1	**Black Bayou Sabine River Maintenance Dredging (792 acres)**	**LA 3-10R**	**198**	**753,717**
I_1	Black Bayou GIWW Dedicated Dredging (546 acres)	LA 3-15A	231	685,753
I_2	Black Bayou GIWW Dedicated Dredging (1,043 acres)	LA 3-15A LA 3-18A	470	1,695,472
J_1	Black Bayou GIWW Dedicated Dredging (497 acres)	LA 3-18A	239	1,009,720
K_1	Black Bayou GIWW Dedicated Dredging (683 acres)	LA 3-15B	307	833,787
K_2	**Black Bayou GIWW Dedicated Dredging (1,304 acres)**	**LA 3-15B LA 3-18B**	**617**	**2,079,427**
L_1	Black Bayou GIWW Dedicated Dredging (621 acres)	LA 3-18B	310	1,245,640
Gulf Shoreline Nourishment				
M_1	Louisiana Point Gulf Shoreline Nourishment – SNWW new work material – 0.5 mile	LA 5-3	5	97,144
M_2	Louisiana Point Gulf Shoreline Nourishment – SNWW new work material (Section 5 only) – 3 miles	LA 5-1 LA 6-1	54	370,062
M_3	Louisiana Point Gulf Shoreline Nourishment - SNWW new work material (sections 5 and 6) – 3 miles	LA 5-5	90	1,087,715

5.4.3 Selection of the Best Buy Mitigation Plan

The result of the incremental analysis is illustrated on Figure 5.4-2 and in Table 5.4-3. Ten best buy plans were identified, with incremental costs ranging from $2,716 to $19,935 per AAHU. Line 1 is the No-Action Plan, with no cost and no output. The first column numbers the plans in order of cost effectiveness, with the most cost-effective plan (Plan 2) shown on the second line. Column 2 in Table 5.4-3 lists the codes for all solutions included in each best buy plan, as determined by the incremental cost analysis. The mitigation alternatives advanced for final screening (discussed previously) are the solutions evaluated by IWR-PLAN. Refer to Table 5.4-2 for a description of the mitigation measure represented by the codes shown in column 2. Column 3 shows the incremental output (in AAHUs) of the solution, which is added with each new best buy plan. Column 4 shows the average annual cost associated with the incremental output (the last solution added) of each best buy plan.

Figure 5.4-2. Results of CE/ICA Analysis

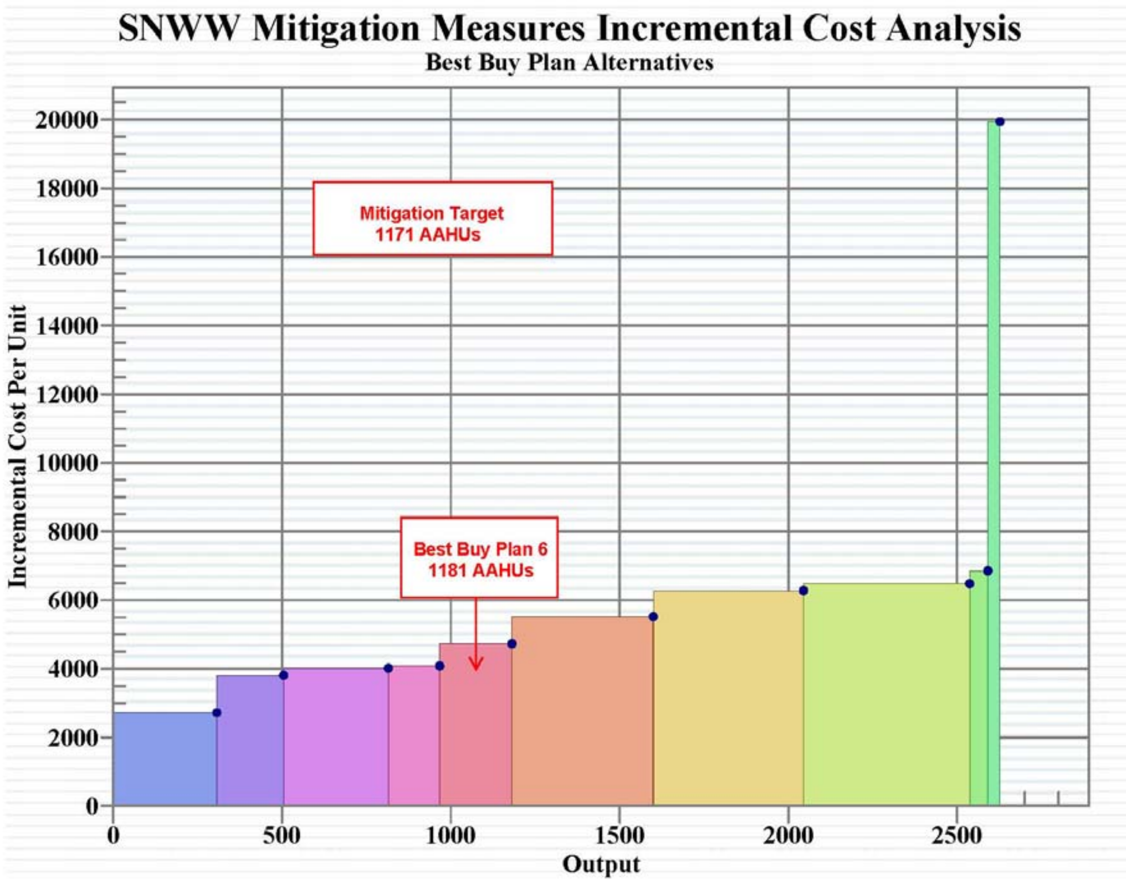


Table 5.4-3
Incremental Cost of Best Buy Plan Combinations (Ordered by Output)

Counter	Plan Alternative	Output (AAHUs)	Cost ($1.00)	Average Cost ($1.00/AAHU)	Incremental Cost ($1.00/AAHU)	Inc. Output ($1.00)	Inc. Cost Per AAHU
1	No-Action Plan	0.00	0.00				
2	A0B0C0D0E0F0G0H0I0J0K1L0M0	307.00	833,787.00	2,715.9186	833,787.0000	307.0000	2,715.9186
3	A0B0C0D0E0F0G0H1I0J0K1L0M0	505.00	1,587,504.00	3,143.5723	753,717.0000	198.0000	3,806.6515
4	A0B0C0D0E0F0G0H1I0J0K2L0M0	815.00	2,833,144.00	3,476.2503	1,245,640.0000	310.0000	4,018.1935
5	A0B0C0D1E0F0G0H1I0J0K2L0M0	967.00	3,454,021.00	3,571.8935	620,877.0000	152.0000	4,084.7171
6	**A0B0C0D2E0F0G0H1I0J0K2L0M0**	**1,181.00**	**4,465,620.00**	**3,781.2193**	**1,011,599.0000**	**214.0000**	**4,727.0981**
7	A0B0C0D3E0F0G0H1I0J0K2L0M0	1,600.00	6,778,538.00	4,236.5863	2,312,918.0000	419.0000	5,520.0907
8	A0B0C1D3E0F0G0H1I0J0K2L0M0	2,045.00	9,573,089.00	4,681.2171	2,794,551.0000	445.0000	6,279.8899
9	A0B0C2D3E0F0G0H1I0J0K2L0M0	2,537.00	12,759,111.00	5,029.2121	3,186,022.0000	492.0000	6,475.6545
10	A0B0C2D3E0F0G0H1I0J0K2L0M2	2,591.00	13,129,173.00	5,067.2223	370,062.0000	54.0000	6,853.0000
11	A0B0C2D3E0F0G0H1I0J0K2L0M3	2,627.00	13,846,826.00	5,270.9654	717,653.0000	36.0000	19,934.8056

Best Buy Plan 2, shown on line 2, consists of Solution K_1; it has the lowest cost per AAHU ($2,716) of all the best buy plans and consists of only the first scale of that solution, with an output of 307 AAHUs. Best Buy Plan 3 adds Solution H_1 to Solution K_1, with an incremental output of 198 AAHUs for Solution H_1, and a total output of 505 AAHUs for the plan. Best Buy Plan 4 consists of Solutions H_1 and K_2; in this case, the difference between total output for this plan and Best Buy Plan 3 (H_1 and K_1) is the incremental output between K_2 and K_1 (815 – -505 = 310 AAHUs). The cumulative output for each successive group of plans is shown in Column 3. The first plan with the cumulative total that exceeds the mitigation target is generally selected as the Best Buy Mitigation Plan.

The incremental annualized cost per unit of output (Column 5) is calculated by dividing total average annual cost for each incremental solution by the output from that solution. For Best Buy Plan 4, the total annualized cost of K_2 (in this case, $1,245,640) is divided by the incremental output (310 AAHUs) to obtain $4,018. Average annual costs were developed for all solutions that were analyzed with IWR-PLAN. These costs include the first cost of construction, marsh plantings, monitoring, and 50-year annualized O&M costs. They are not provided in this document, except as incremental costs per habitat unit, but are available upon request.

Best Buy Plan 6 (Solutions D_2, H_1, and K_2 – shown in bold in tables 5.4-2 and 5.4-3) appears to be an efficient mitigation plan since it reaches the mitigation target of 1,159 AAHUs (Table 5.4-4) by providing a total of 1,181 AAHUs. Best Buy Plan 6 consists of emergent marsh restoration in two Willow Bayou areas (totaling 607 acres) and three areas in the Black Bayou area (totaling 2,096 acres). Best Buy Plan 7 was also evaluated to determine whether its considerable additional benefits were worth the comparatively small incremental cost. Best Buy Plan 7 provides 420 additional AAHUs (719 more acres restored in Willow Bayou) by adding Solution D_3 for an additional average annual cost per unit of output of $4,237 (total average annual cost of $2,312,918). Since the estimated total first cost of this increment is $39,275,000 (screening-level cost) and Best Buy Plan 6 meets the mitigation target, Best Buy Plan 7 was deemed not worth the additional investment.

Table 5.4-4
Recommended Mitigation Plan

Recommended Mitigation Plan	Mitigation AAHUs
Willow Bayou	
LA 2-18 B Marsh Restoration (Sabine Lake dredging)	152
LA 2-ADD B Marsh Restoration (Sabine Lake dredging)	214
Black Bayou West	
LA 3-10R Marsh Restoration (Sabine River Channel maintenance material)	198
Black Bayou East	
LA 3-15 B Marsh Restoration (GIWW dredging)	307
LA 3-18 B Marsh Restoration (GIWW dredging)	310
Total Compensation	1,181
FWP Mitigation Target	–1,159
Net Benefits After Compensation	**22**

5.5 RECOMMENDED MITIGATION PLAN

The CE/ICA selected Best Buy Plan 6 as the most efficient combination of mitigation measures to compensate for the indirect impacts of the Preferred Alternative. It provides 1,181 AAHUs, which is 10 AAHUs more than the mitigation target. It is important to remember that additional compensatory mitigation would be provided in Louisiana beyond the total 843 AAHUs impacts of the Preferred Alternative. The mitigation plan would result in a net gain of 338 AAHUs for the project as a whole.

Unavoidable impacts of the SNWW CIP remain only in Louisiana; all CIP impacts in Texas are minimized and offset by the DMMP, and no mitigation is required. Therefore, all of the mitigation measures in Best Buy Plan 6 would be located in Louisiana. The mitigation plan consists of restoring five degraded marsh areas east of Sabine Lake near Willow and Black bayous, Louisiana (Table 5.5-1, Figure 5.5-1). Each of these alternatives is described in detail below. The recommended Mitigation Plan compensates for the Preferred Alternative's salinity increase and associated losses in marsh and productivity by marsh creation activities that would influence a total of 8,095 acres of Louisiana marshes in the Willow and Black Bayou watersheds. The plan would restore 2,783 acres of emergent marsh in existing open-water areas within the marsh, improve 957 acres of shallow-water habitat by creating shallower, smaller ponds and channels within the restored marsh, and stabilize and nourish 4,355 acres of existing marsh located in and around the marsh restoration zone. The amount of recommended mitigation is based upon the amount of marsh acreage that could be lost as a result of the project, and the additional amount that would need to be restored in order to fully compensate for adverse changes to biological function of the remaining marsh throughout the affected area over the 50-year period of analysis. More than a one-to-one ratio of created marsh to natural marsh is needed to fully compensate for the loss of marsh productivity caused by the CIP. Studies by NMFS (Minello, 2000; Minello and Webb, 1997) have shown that created marshes are not functionally equivalent to natural marshes for all estuarine species for as much as 15 years after the marshes are planted. In total, these measures would produce 1,159 AAHUs and provide full compensation for all impacts of the CIP. The USACE and the ICT would monitor all of the mitigation areas as described by the monitoring plan presented in Appendix I.

Table 5.5-1
Recommended Mitigation Plan – Acreage Analysis

Mitigation Measure	AAHUs	Total Influence Area (acres)	Nourished Existing Marsh (acres)	Restored Open Water (acres)	Restored Emergent Marsh (acres)
Willow Bayou					
LA 2-18B	152	681	367	63	251
LA 2-ADD B	214	1,285	745	104	436
Subtotal	366	1,966	1,112	167	687
Black Bayou West					
LA 3-10R	198	2,465	1,317	356	792
Black Bayou East					
LA 3-15B	307	1,788	878	227	683
LA 3-18B	310	1,876	1,048	207	621
Subtotal	617	3,664	1,926	434	1,304
Total Mitigation	1,181	8,095	4,355	957	2,783

Specific performance criteria for the marsh restoration areas were established in consultation with the ICT: (1) placed material would be 60 to 80 percent vegetated with native, typical, emergent marsh 5 years after each placement of material; (2) marsh would remain intact and 60 to 80 percent vegetated with native, typical, emergent marsh through the 50-year period of analysis; and (3) invasive, noxious, and/or exotic plants would compose less than 4 percent of marsh cover at year 2 and year 5.

5.5.1 Willow Bayou Mitigation

Recommended Willow Bayou mitigation measures (LA 2-18B and LA 2-ADD B) are located within the boundaries of the Sabine NWR (see Figure 5.5-1). The USACE has requested that the USFWS prepare a compatibility determination for the proposed activity. See correspondence dated January 24, 2007, in Appendix A1. Material dredged from a borrow trench in Sabine Lake would be used to restore 687 acres of emergent marsh within open-water areas, improve 167 acres of shallow-water habitat, and nourish 1,112 acres of existing marsh within the total influence area of 1,966 acres (see Table 5.5-1). Small ponds and sinuous, interconnected channels would be created to maintain tidal connectivity, increase marsh edge, and create protected areas for SAV. Approximately 1,966 acres of existing marsh in the influence area would also be renourished by winnowing fine-grained suspended solids during placement events. Marsh would be constructed by the unconfined flow of dredged material from a hydraulic pipeline. Frequent pipe movement and careful elevation control would be necessary to obtain the appropriate marsh elevations. In order to maximize edge in the marsh, topographic relief would be created by varying the final elevation of material placement, and planting with appropriate native flora at each elevation. The varied topography would allow for differences in duration of tidal inundation, create different floral communities, and maximize biodiversity. Tidal creek channels would be constructed in the marsh creation area after the dredged material has settled. These would be needed to return the area to normal tidal regime, facilitate marine organism access, and allow water and nutrients to flow into the area.

The dedicated dredging would take approximately 3.1 mcy of material from a 1.8-mile-long borrow trench in Sabine Lake. The borrow trench would be located at least 1,000 feet from the Sabine NWR shore and would average 1,030 feet wide by 7.5 feet deep. The borrow trench would be continuous and parallel to the current shoreline, in line with the common longshore circulation pattern in Sabine Lake. The circulation is expected to prevent the development of hypoxic conditions that would be detrimental to aquatic organisms, and would eventually fill the trench with Sabine River sediments. An access channel, approximately 8 miles long, from the GIWW near the mouth of the Sabine River would be needed for the dredge to reach the proposed borrow area. The exact locations of the borrow trench and access channel would be determined in consultation with the ICT after PED bottom surveys of potential locations. The USACE and ICT would monitor these mitigation areas in accordance with the specific success criteria and monitoring plan presented in Appendix J.

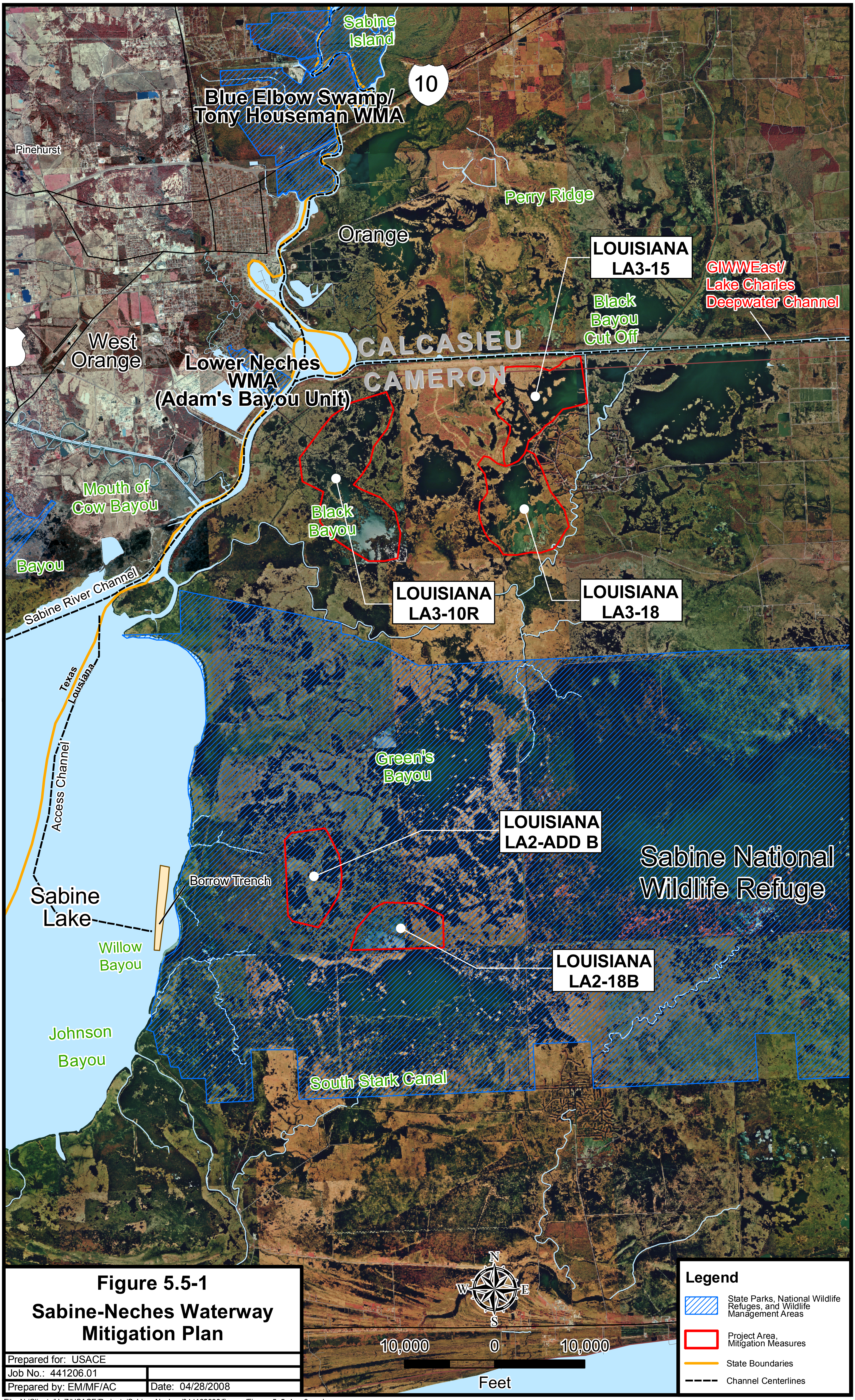


Figure 5.5-1
Sabine-Neches Waterway Mitigation Plan

Prepared for: USACE	
Job No.: 441206.01	
Prepared by: EM/MF/AC	Date: 04/28/2008

File: N:/Clients/U_Z/USACE/Projects/Sabine_Neches/044198000/figures/Figure_5_5_1_vr6.mxd

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One-time impacts of the borrow trench and access channel dredging would include an increase in water column turbidity during dredging activities; such effects are temporary and local to nekton, phytoplankton, and water quality. A hydraulic pipeline dredge would be used to minimize turbidity. For further information, see subsection 4.11.2.1. No further effects to water quality and related organisms would be expected. Benthic fauna would be removed due to excavation of sediment during dredging activities; however, benthic organisms can rapidly recolonize and no long-term effects are anticipated. Due to low salinity (1 to 6 ppt) in this area of Sabine Lake, live oyster reefs are not likely (Fagerberg, 2003). A study by T. Baker Smith, Inc. (2006) found no live oyster reefs in this area. SAV cover is not likely to be found in this area due to the prevalence of shallow, turbulent, and turbid water.

5.5.2 Black Bayou Mitigation

For the Black Bayou West (LA 3-10R) mitigation measure, material from maintenance dredging of the Sabine River Channel between East Pass and the GIWW would be used to restore a large area of marsh north of Black Bayou and west of Rusty Vincent Lake (see Figure 5.5-1 and Table 5.5-1). Maintenance dredging of the Sabine River Channel is considered a separate project within the SNWW system, with a different non-Federal sponsor. It is a without-project condition for the SNWW CIP, and therefore only the incremental cost associated with placing the material in the marsh is included in the cost estimate for the Preferred Alternative. Material removed during regularly scheduled maintenance dredging of this channel would be hydraulically pumped into a large degraded marsh area west of Rusty Vincent Lake. This area is close to the navigation channel, minimizing pumping distance and cost. Marsh restoration in LA 3-10R would be accomplished in six 5-year dredging cycles beginning by the first year of the completion of CIP construction. Each dredging cycle would pump approximately 526,000 cy of material to create 132 acres; a total of 792 acres of emergent marsh would be created over 30 years; 356 acres of shallow-water habitat would be improved, and 1,317 acres of existing marsh would be nourished within the total 2,465 acres influenced by the unconfined flow of dredged material.

For the Black Bayou East (LA 3-15B and LA 3-18B) mitigation measures, marsh restoration would be accomplished in two areas just west of the Black Bayou Cutoff Canal using dedicated dredging of accumulated material in the Lake Charles Deepwater Channel/GIWW (see Figure 5.5-1 and Table 5.5-1). The Lake Charles Deepwater Channel was constructed in 1926 and coincides along its entire 24.9-mile length with the GIWW between the Sabine River and Lake Charles (USACE, 1998c). Communications with the New Orleans District indicate the depth of the 30-foot channel has been reduced to approximately 12 feet due to sedimentation.

Dedicated dredging of the Lake Charles Deepwater Channel for the Black Bayou mitigation efforts would remove and kill benthic organisms; however, constant ship traffic in the shallow channel is an ongoing disturbance to these organisms. Recovery of benthic organisms would be rapid (Sheridan, 1999). No impacts to salinity would be expected because the dredged section would not connect with the Sabine River Channel or the Calcasieu Ship Channel; therefore, there would be no connection with the saltwater wedge in the Calcasieu Ship Channel (there is no Sabine River wedge; Brown and Stokes, 2009) It is expected that sediment would accumulate over time, refilling the channel to its current depth of approximately –12 feet.

Approximately 10.5 mcy of material would be pumped from a 13-mile stretch of the GIWW approximately 125 feet wide (the width of the GIWW/Deepwater Channel) into the two areas. The first (LA 3-15B) would be located adjacent to the GIWW and would have the shortest pumping distance; the second would be located south of LA 3-15B, and pumping would move to it after the first is complete. A total of 1,304 acres of emergent marsh would be restored, 434 acres of shallow-water habitat would be improved, and 1,926 acres of existing marsh would be nourished within the total 3,664 acres influenced by the unconfined flow of dredged material.

Marsh would be constructed by the unconfined flow of dredged material from a hydraulic pipeline. Frequent pipe movement and careful elevation control would be necessary to obtain the appropriate marsh elevations. In order to maximize edge in the marsh, topographic relief would be created by varying the final elevation of material placement, and planting with appropriate native flora at each elevation. The varied topography would allow for differences in duration of tidal inundation, create different floral communities, and maximize biodiversity. Tidal creek channels would be constructed in the marsh creation area after the dredged material has settled. These would be needed to return the area to the normal tidal regime, facilitate marine organism access, and allow water and nutrients to flow into the area. The USACE and ICT would monitor these mitigation areas in accordance with the specific success criteria and monitoring plan presented in Appendix J.

5.5.3 Comparison of Recommended Mitigation Plan to Mitigation Planning Objectives

The net benefits of the Mitigation Plan are shown in tables 5.4-4 and 5.5-1. Compensatory mitigation was considered only after impacts were minimized and offset by DMMP BU features. The DMMP features maximize, to the greatest degree possible, the use of dredged material as a beneficial resource, and share the material from Sabine Pass equally between the states. The mitigation plan (+1,181 AAHUs) fully compensates for AAHU losses to state resources in Louisiana and results in a net gain of 338 AAHUs for the project as a whole. Impacts to East Sabine Lake marshes are replaced in-kind by the marsh mitigation plans in Willow and Black bayous. Minor productivity impacts to cypress-tupelo swamp on the Sabine River near the GIWW are not matched in-kind. The ICT considered this to be acceptable since the loss in function is negligible. Projected FWP salinity levels are within the tolerance levels of these swamps, and the CIP causes no loss of swamp acreage.

5.5.4 Performance Criteria for DMMP Restoration/Nourishment and Mitigation Areas

5.5.4.1 Design and Construction

General performance criteria for marsh design and construction for DMMP BU features and Louisiana mitigation measures are presented below. Reference marshes would be located near to mitigation sites so that vegetation, salinity regime, and hydrology would be directly comparable. Specific criteria would be developed during the PED phase.

Goals and Objectives

- To create intertidal marshes compatible with the surrounding natural environment using dredged material.
- To reach consistent and similar intertidal fluctuations that mimic existing nearby marshes to provide habitat suitable for local species to survive and grow.
- To create a sustainable habitat that would withstand environmental conditions and anthropogenic impacts for the period of analysis.

Methods

- Build or reinforce existing containment levees adjacent to large canals with mechanically dredged, in situ material. Keep containment levees to the minimum necessary to prevent filling of adjacent navigable canals.
- Place hydraulically dredged material within degraded marsh areas and allow unconfined flow over larger influence areas.
- Frequently move pipe to prevent the accumulation of unsuitably high elevations of material.
- Allow fine-grained sediments to winnow through fringing marsh while material settles at discharge locations.
- Shape the material where required and plant vegetation to sustain the intertidal habitat over time.

Standards

- A sustainable marsh habitat maintained.
- Marsh elevations and geotechnical factors shall fall within certain parameters set in the design.
- Marsh water depths, water quality, water temperatures, DO levels, and salinity of the created marsh shall be favorable to expected flora and comparable to those in reference marshes.
- Water displacement over the tidal cycle shall be similar to reference marshes.

Monitoring and Contingency Plans

Monitoring and contingency plans for the mitigation measures and DMMP BU features are presented in Appendix J. The monitoring and contingency plans for mitigation measures and BU features have been developed in accordance with recent implementing guidance for sections 2036 (a) and 2039, respectively, of WRDA 07, and the monitoring plans for beneficial use of dredged material in Texas and Louisiana as required by the Section 2039 guidance.

The monitoring plans identify specific ecological success criteria to be used in determining whether the mitigation and BU DMMP features have been successful. Details of the monitoring plan for all of the mitigation sites in Louisiana and the BU features are presented in tables 3 and 4, respectively, of Appendix J. These tables present the key monitoring parameters, periodicity, costs, and responsible parties.

Periodic monitoring to determine the success of marsh mitigation measures and DMMP BU features would continue until the Division Commander determines that the ecological success criteria of the mitigation and DMMP BU features have been met. This determination would be based upon monitoring results and ICT consultation reports provided by the District Engineer. The ICT would be consulted annually to determine progress in the planning, construction, and postconstruction evaluation of the ecological success of these features.

5.5.4.2 Implementation

Upon authorization of the CIP, the USACE would use its Navigational Servitude to obtain access for construction of the Texas and Louisiana DMMP BU features and the Louisiana mitigation measures, for the purposes of planning, construction, and postconstruction monitoring. Landowners would be advised of the need for access. All restored areas would remain jurisdictional wetlands and continue to be subject to the Servitude; therefore, conservation easements would not be required. Agencies on the ICT have requested the opportunity to provide input to the future engineering, design, construction, and monitoring of the project. The ICT would participate in the detailed planning of the marsh creation areas during the PED phase, monitor construction of the mitigation areas, and participate in planning and conducting postconstruction monitoring.

6.0 CONSISTENCY WITH TEXAS AND LOUISIANA COASTAL MANAGEMENT PROGRAMS

In an effort to encourage states to better manage coastal areas, Congress enacted the CZMA in 1972. Texas and Louisiana both have developed and continue to implement federally approved coastal zone management programs and plans (TCMP and LCMP, respectively). States with approved plans have the right to review Federal activities (including private activities that require Federal permits) to determine whether they are consistent to “the maximum extent practicable” with the policies of the state’s coastal zone management program. Appendix I addresses the compliance of the Preferred Alternative in this FEIS with the TCMP and LCMP in full detail.

In summary, coastal natural resource areas (CNRAs), would be affected by the Preferred Alternative. The Preferred Alternative is a result of evaluating six project designs, several mitigation approaches, and beneficial uses of dredged material. Evaluations were made by an ICT and involved extensive modeling of ecological functions based on potential impacts, RSLR, and mitigative measures. The alternatives evaluations included attempts to minimize and avoid CNRAs to the maximum extent practicable and provide overall benefits to the ecosystem functions.

No net loss of coastal wetlands was a specific goal of the SNWW CIP ICT and alternatives evaluation. Several components of the DMMP and mitigation plan involve restoration, protection, and enhancement of coastal wetlands. The Neches River BU Feature would restore 2,853 acres of emergent marsh, nourish 1,234 acres of existing marsh, and improve 871 acres of shallow-water habitat. Additionally, the mitigation plan consists of restoring five degraded marsh areas east of Sabine Lake near Willow and Black bayous, Louisiana. This mitigation measure would restore 2,783 acres of emergent marsh in existing open-water areas within the marsh, improve 957 acres of shallow-water habitat by creating shallower, smaller ponds and channels within the restored marsh, and stabilize and nourish 4,355 acres of existing adjacent marsh.

USACE has evaluated the proposed SNWW CIP for consistency with the Texas and Louisiana coastal management programs, and concluded that the Recommended Plan is fully consistent to the maximum extent practicable with the enforceable policies of both state programs. An ICT comprised of Federal and State resource agency representatives from Texas and Louisiana assisted USACE over a nearly 10-year period to perform appropriate scientific studies and modeling needed to ensure that the proposed project avoids and minimizes environmental impacts to the greatest extent practicable. USACE in particular notes that State and Federal agencies including USFWS, NMFS, TPWD, TCEQ, LDEQ, and the EPA have expressed no outstanding concerns with the project. By letter dated March 30, 2010, the Texas Coastal Coordination Council concurred with the USACE consistency determination. By letter dated March 31, 2010, the LDNR Office of Coastal Management (OCM) found that the SNWW CIP is conditionally consistent with their state program. The finding requires that USACE submit an additional consistency determination no later than the time at which draft contract plans and specifications are circulated for internal review. A requirement of the conditional consistency is the submission of additional detailed information on topics that “would include, but not be limited to, the topics of storm surge, bar channel deepening, salinity, borrow from Sabine Lake, mitigation plans and adequacy, and pipeline relocation.” The letter also notes that the USACE letter to LDNR-OCM, dated March 19, 2010, does not constitute an adequate resolution to the issues described. USACE consulted with LDNR (as a member of the ICT) concerning technical issues raised in this letter, and issues originally approved by LDNR as a member of the ICT are now being reopened. USACE maintains that the issues, as summarized below, have been adequately addressed. Since USACE finds that the Recommended Plan is consistent to the maximum extent practicable with the enforceable policies of the LCMP, USACE does not accept conditional consistency as proposed by LDNR-OCM. By letter dated April 26, 2010, USACE notified LDNR of its finding and that it will proceed with the project.

Storm Surge

LDNR asserts that the effects of the deeper shipping channel and the borrow of material from the GIWW and Sabine Lake may be significant and have not been modeled thoroughly enough to identify all potential impacts. ERDC-CHL was consulted about the need to model the salinity effect of borrowing material from the GIWW and Sabine Lake relative to salinity impacts. Neither feature was expected to increase salinity impacts, and so they were not included in the HS modeling.

ERDC was also consulted on the potential for ODMDSs to increase wave set-up and erosion on Louisiana shores. ODMDS sites are located too far from shore and in water too deep to affect the Louisiana shore. Waves of any consequence present within a thousand feet of the shoreline are generally depth limited because of the mild nearshore slope and the presence of a soft mud (PIE, 2003). The closest ODMDS (#4) is located between 3.8 and 6 miles from Louisiana in 34 to 43 feet of water. Appendix B discusses previous monitoring of this ODMDS and studies of bottom ocean currents in the region that have determined the dredged material would disperse between placement cycles and not accumulate, and thus would not affect wave set-up or erosion.

ERDC has just completed a sensitivity analysis of potential storm surge impacts from the deeper shipping channel and placement areas (Wamsley, Cialone, and McAlpin, 2010). The analysis is discussed in more detail in subsection 4.6.2.1. The analysis clearly and unequivocally identifies no impact to Louisiana from the deflection of storm surges by the higher PA levees or from the deeper navigation channel. Therefore, further modeling to identify impacts is not necessary.

Bar Channel Deepening

Modeling of potential impacts on wave climate has been performed by ERDC-CHL as reported by Gravens and King (2003). The report has been presented on the USACE, Galveston District’s SNWW webpage since 2003, and it is reported in here in subsection 4.6.2.2. The modeling addressed the changes in the wave climate that would be produced by a deeper and longer offshore channel, including the Outer Bar Channel. In the first 2 miles east of Sabine Pass, the net eastward transport would be slightly reduced (by a maximum of about 1,400 cy/year), and farther east there would be essentially no change. For a

50-foot project, between ½ mile and 3–4 miles of the east jetty, the accretion would decrease by less than 0.5 foot/year, and farther from the jetties than that, the change in the shoreline would decrease to zero. This small impact would be more than offset by the proposed Gulf Shore BU feature's regular shoreline nourishment at Louisiana Point.

Salinity

LDNR asserts that the SNWW salinity modeling used questionable assumptions and boundary conditions, and data collected over a short and nonrepresentative time period. Boundary conditions and assumptions were developed by ERDC and coordinated with the ICT in numerous meetings of the ICT and its MW from 2000 to 2004, and the revised HS modeling presented at the last ICT meeting on August 27, 2009. While LDNR participated in most of the MW meetings, and all prior ICT meetings, no representatives from LDNR attended the last ICT meeting. The ICT presented no objections to the revised modeling at this meeting. The HS modeling for the Preferred Alternative has been subjected to extensive agency technical review (ATR) and independent external peer review (IEPR). ATR identified no significant concerns. The primary IEPR concern related to the need to include the effects of relative sea level rise. This was included as demonstrated in the latest the HS modeling report (Brown and Stokes, 2009). As part of the ICT, LDNR participated in the development of modeling assumptions and reviewed the modeling results. No negative comments were received prior to the consistency determination coordination.

Borrow Site in Sabine Lake

LDNR has requested more information on design details regarding the proposed Sabine Lake borrow trench for the Willow Bayou mitigation areas. USACE has agreed to provide all of the information (i.e., geotechnical information on borrow quality, analysis of potential access channels, and disposal plans) needed to develop detailed engineering plans during the PED phase. Designs would minimize impacts to the maximum extent practicable. This FEIS (subsection 5.5.1) fully evaluates potential impacts of the access channels and borrow area and has determined that impacts would be minimal and temporary.

LDNR also requires that mitigation of oyster seed ground impacts must be accomplished to the satisfaction of LDWF. The exact locations of the borrow trench and access channel would be determined in consultation with the ICT after PED bottom surveys of potential locations. The proposed route of the access channel was chosen to keep dredging impacts to a minimum; it takes advantage of deeper water in the center of the lake, thereby minimizing dredging and bottom impacts. Due to low salinity in this area of Sabine Lake, live oyster reefs are not likely (Fagerberg, 2003; T. Baker Smith, 2006). Nevertheless, as stated in subsection 5.5.1 and in the USACE letter dated March 4, 2010, to LDWF, USACE has proposed that a water-bottom survey of the borrow and access channel areas be conducted during the PED phase of the project. In the unlikely event that oyster reef is encountered, plans will be revised to avoid impacts.

LDNR-OCM asserts that royalty payments and license issues over sediment resources must be resolved with LDWF before LDNR-OCM can concur that the final design is consistent, to the maximum extent practicable, with Louisiana Coastal Resources Program. USACE maintains that the United States is not bound by Louisiana statute (R.S. 56:2011) pursuant to the Supremacy Clause of the United States Constitution, and that Louisiana is not entitled to compensation under the Fifth Amendment, pursuant to the doctrine of Navigation Servitude. This servitude gives the Federal Government the right to use the "Navigable Waters" of the United States without compensation for navigation projects. In a letter dated March 19, 2010, on the issue of payment of royalties, the USACE provided a detailed legal and policy analysis to support the conclusion that no royalty payments are proper or allowable under current Federal law.

Mitigation Plans and Adequacy

LDNR asserts that details of the proposed mitigation are insufficient to determine whether all potential losses will be adequately compensated. USACE disagrees—mitigation site locations have been finalized, and conceptual designs are sufficient to support ecological modeling of the compensatory mitigation. USACE has agreed to work with the ICT (which includes LDNR) to obtain all of the information needed to develop detailed engineering plans, including geotechnical data relevant to site design, during PED.

LDNR asserts that the proposed mitigation plan falls at least 318 AAHUs short of replacing the anticipated habitat losses to Louisiana, and that additional mitigation will have to be performed in Louisiana to offset this deficit. USACE maintains that the proposed mitigation plan would more than compensate for all impacts of the proposed SNWW CIP. LDNR has questioned the use of benefits from BU features in Texas to offset impacts in Louisiana (see Table 5.1-2). In Louisiana, the benefits of BU measures offset the loss of 210 AAHUs to private lands along the coast at Louisiana Point, and the loss of 340 AAHUs to Federal land in the SNWR. Exclusion of the Federal SNWR is based upon the definition of "coastal zone" in the Coastal Zone Management Act of 1972, as amended. "Excluded from the coastal zone are lands the use of which is by law subject solely to the discretion of or which is held in trust by the Federal Government, its officers or agents (16 USC §1453)." The net impact of the project to non-Federal lands in Louisiana after application of BU benefits is the loss of 1,159 AAHUs, and the proposed mitigation plan would provide 1,181 AAHUs in order to fully and separately compensate losses to these lands. Furthermore, the Louisiana marsh mitigation measures would compensate for the predicted loss of 691 acres in Louisiana over 50 years by the restoration of 2,783 acres of emergent marsh, the improvement of 957 acres of shallow-water habitat, and the nourishment of 4,355 acres of existing marsh. Since the marsh restoration is several times greater than the predicted marsh loss, there would be no net loss of wetlands.

LDNR has also questioned the benefits of the Gulf Shore BU feature at Louisiana Point, and asserts that additional mitigation in Louisiana will be required unless acceptable technical justification of the projected benefits is provided. The benefits of the BU feature in Louisiana were established by WVA modeling accomplished by the ICT, of which LDNR was a part. The technical justification presented in Appendix C, subsection 8.3.1.2 and WVA modeling were reviewed and accepted by the ICT. The monitoring plan (Appendix J) would determine whether benefits are being reached as predicted.

Pipeline Relocation

A total of 104 pipelines have been identified crossing the SNWW navigation channels. Of the 104 pipelines, 46 require adjustment to meet the minimum required vertical and horizontal clearances for the SNWW CIP. The individual circumstances of each pipeline will be evaluated by USACE in consultation with the non-Federal sponsor and the pipeline owner during the PED and Construction phases, and decisions regarding necessary actions will be made individually for each pipeline at that time. Costs of pipeline relocations have been included in the economic analysis of potential project benefits. Direct and indirect economic benefits of the proposed deepening will accrue to all users of the SNWW, including the energy industries, and to the regional economy in Louisiana as established by an independent economic analysis (Martin Associates, 2006). The economic analysis presented in FFR Section V.F establishes that there would be a net economic benefit to the country from the proposed project. Minimal impacts to Louisiana industries are anticipated because construction would work around pipeline relocations as needed to accommodate all parties for a safe, effective, and minimally disruptive working plan.

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7.0 CONSISTENCY WITH OTHER STATE AND FEDERAL PLANS AND REGULATIONS

This FEIS has been prepared to satisfy the requirements of all applicable environmental laws and regulations and has been prepared using the CEQ NEPA regulations (40 CFR Part 1500–1508) and the USACE's regulation ER 200-2-2 (*Environmental Quality: Policy and Procedures for Implementing NEPA*, 33 CFR 230). The USACE will follow provisions of all applicable laws, regulations, and policies related to the proposed actions, including those for which applicability, review, and enforcement are their responsibility. Additionally, the local sponsor may be required to secure local municipal permits as a "Land, Easements, Rights-of-Way, Relocation, and Disposal Areas" requirement. The following sections present brief summaries of Federal environmental laws, regulations, plans, and coordination requirements applicable to this FEIS.

7.1 NATIONAL ENVIRONMENTAL POLICY ACT

This FEIS has been prepared in accordance with CEQ regulations in compliance with NEPA provisions. All impacts on terrestrial and aquatic resources have been identified, significant adverse impacts requiring mitigation have been identified, and mitigation has been proposed.

7.2 RIVER AND HARBOR ACT OF 1899

Sections 9 (33 USC 401) and 10 (33 USC 403) are related to structural construction and dredge-and/or-fill activities, respectively, within U.S. navigable waterways. The USACE authorizes permits under this statute. While the agency would not issue a permit for its own actions, the USACE would meet and be consistent with all applicable elements of the statute. Additionally, the USACE and ICT determined that dredged material testing was required under the related Regulatory Guidance Letter 06-02 (*Guidance on Dredged Material Testing for Purposes of Section 404 of the Clean Water Act, Section 10 of the Rivers and Harbors Act, and Section 103 of the Marine Protection, Research, and Sanctuaries Act of 1972*, July 6, 2002). Results are presented in sections 3.3 and 3.4.

7.3 CLEAN WATER ACT

USACE has received §401 State Water Quality Certification from Texas and Louisiana for this action. Both states have determined that the requirements for water quality certification have been met and have concluded that the placement of fill material will not violate water quality standards of each state. The Preferred Alternative is the least environmentally damaging practicable alternative. A CWA §404(b)(1) evaluation of the proposed action, provided in Appendix E of this FEIS, describes the effects of the proposed discharges. Short-term increases in turbidity may be caused by the unconfined flow of dredged material during construction of BU features and mitigation measures. Proposed channel improvements should decrease the number of vessel trips, thus decreasing the probability of a spill.

Appendix E of this FEIS contains the §401(b)(1) evaluation needed for state water quality certification. All relevant sediment and water quality data for both new work and maintenance dredging material were reviewed by a team of State and Federal resource agencies (the CW of the ICT), including the TCEQ and LDEQ, and they found no cause for concern over water or sediment quality in any channel reach. New work sediments were deemed suitable for use in constructing BU or mitigation sites and upland confined PAs, although excess new work material would have to be placed in upland confined PAs. Maintenance material would be handled according to the DMMP. The DMMP measures maximize, to the greatest degree possible, the use of dredged material as a beneficial resource, and share the material from Sabine Pass equally between the states.

7.4 CLEAN AIR ACT of 1970

The CAA is the comprehensive Federal law that regulates air emissions from area, stationary, and mobile sources. An analysis of estimated air contaminant emissions from equipment (including dredges and support equipment such as tugboats, runabouts, and tenders, as well as land based equipment such as bulldozers and employee vehicles) associated with the proposed CIP is expected to result in short-term impacts on air quality in the immediate vicinity of the project area, but no long-term impacts are expected. Emissions of VOC for the project are exempt from a General Conformity Determination because they are below the general conformity threshold of 100 tons per year. However, estimated NO_x emissions for the Preferred Alternative exceed the general conformity threshold; i.e., greater than 100 tpy, for all years of construction.

Pursuant to Section 176 of the CAA Amendments of 1990, the USACE prepared a document entitled, "Draft General Conformity Determination, Sabine-Neches Channel Improvement Project." This document was noticed for public comment and was submitted by the USACE to the TCEQ, the EPA, and other air pollution control agencies, as appropriate, concurrently with this DEIS. As part of the General Conformity process, the USACE made this document available to the public for review and comment for a period of 30 days. The TCEQ has provided written concurrence that emissions from the Preferred Alternative are conformant with the Texas SIP for the BPA (Appendix A1). Based on TCEQ's comments, the USACE has prepared a Final General Conformity Determination for the proposed SNWW CIP (Appendix F).

7.5 NATIONAL HISTORIC PRESERVATION ACT OF 1966

Compliance with the NHPA of 1966, as amended, requires identification of all NRHP-listed or NRHP-eligible properties in the project area and development of mitigation measures for those adversely affected in coordination with the Texas and Louisiana SHPOs and the Advisory Council on Historic Preservation. As indicated in Section 3.13, this project would not impact NRHP-listed properties or SALs; however, it may potentially adversely impact terrestrial and marine historic properties eligible for listing in the NRHP. This FEIS has been coordinated with the Texas and Louisiana SHPOs. An HPPA (Appendix H) has been executed among the Texas and Louisiana SHPOs, the SNND and USACE to address subsequent investigations, coordinate surveys of impact areas, test potentially eligible sites, and manage data recovery or avoidance measures as necessary. Tribal coordination, required by the NHPA, has been conducted. Tribes with historical or cultural ties to the region were contacted early in the study to identify their interests and concerns. The draft Programmatic Agreement has also been coordinated with the Tribes. No Tribes have requested to become consulting parties, and no impacts to Tribal land or traditional cultural properties have been identified.

7.6 ENDANGERED SPECIES ACT

Potential impacts to federally listed threatened and endangered species have been assessed by the USACE in a BA. The BA determined that several federally listed species of sea turtles and wintering populations of the piping plover and its Critical Habitat could potentially be affected by project construction or operation. The BA concluded that the Preferred Alternative would not jeopardize the continued existence of piping plovers or result in the adverse modification of its designated Critical Habitat. Potential impacts to sea turtles from hopper dredging were identified, and interagency consultation under Section 7 of the ESA was initiated. NOAA/NMFS responded with a BO as outlined under Section 7(c) of the ESA of 1973, as amended. The BA and BO are presented in Appendix G of this FEIS; other related correspondence is present in Appendix A2. While the project alternative changed, project-related impacts remained the same and therefore the BO conclusions would remain the same.

Potential impacts to the wintering piping plover would be associated with implementation of the Gulf Shore BU Feature. The recurring placement of dredged material for shoreline nourishment would affect areas of designated Critical Habitat. The USFWS has designated the entire shoreline between Constance Beach and Sabine Pass (Unit LA 1, in part) as Critical Habitat for wintering piping plover. Proposed beach nourishment activities at Louisiana Point would occur along approximately 3 miles of this unit, beginning approximately 0.5 mile east of Sabine Pass. No designated Critical Habitat, or even suitable habitat, is present along the Texas portion of the Gulf Shore BU Feature. The USFWS, in letters dated March 20 and March 22, 2007 (Appendix A2), concurred that the Preferred Alternative is not likely to adversely affect the piping plover or its Critical Habitat and the brown pelican. The USFWS Louisiana Field Office stated that no further ESA consultation would be required with its office unless changes are made to the scope or location of the project. The USFWS Clear Lake Field Office letter was silent on the need for further consultation. However, the USACE staff confirmed by telephone that no further ESA consultation would be required unless changes are made to the scope or location of the project. The Clear Lake Field Office did recommend that steps be taken to determine whether bald eagles are nesting within or near the project area since the number of bald eagles in Texas is increasing. Prior to project construction, the USACE would check with the TPWD and local landowners to determine whether there have been recent bald eagle sightings and determine the need for surveys and further coordination at that time.

The USFWS provided further guidance in a letter dated February 5, 2010, and recommended that all activity in Louisiana occurring within 2,000 feet of a brown pelican rookery be restricted to the non-nesting period (i.e., September 15 through March 31). However, because nesting periods vary considerably among Louisiana's colonies, it is possible that this activity window could be altered based upon the dynamics of the individual colony. Prior to project construction, the LDWF Fur and Refuge

Division will be contacted to obtain the most current information about the nesting chronology of individual brown pelican colonies. In Texas, the USFWS recommended all activity occurring within 1,000 feet of a rookery be restricted to the non-nesting season.

Loggerhead, Kemp's ridley, hawksbill, leatherback, and green sea turtles may be present in the study area waters during certain times of the year. Construction and postconstruction maintenance activities involving the use of hopper dredges could result in impacts to sea turtles. No critical habitat for sea turtles is present in the study area, and there have been no reports of sea turtles nesting in the study area, as most of the shoreline is an eroding, muddy marsh. The NMFS has concluded that hopper dredging during construction and maintenance is likely to adversely affect but is not likely to jeopardize the continued existence of loggerhead, Kemp's ridley, hawksbill, leatherback, or green sea turtles. The Opinion authorizes incidental lethal take of four turtles (three Kemp's ridley sea turtles and one loggerhead or green sea turtle) during the course of the proposed project's hopper dredging. Only incidental takes that occur while the specified reasonable and prudent measures are in full implementation are authorized. These measures specify that (1) dredging should be completed, whenever possible, within specified temperature and date-based dredging windows; (2) NMFS-approved protected species observers must provide 100 percent monitoring during certain date and temperature-determined periods; (3) rigid deflector dragheads must be used on hopper dredges at all times; and (4) relocation trawling is required after the take of one sea turtle during the project. The Opinion authorizes the per-fiscal-year nonlethal noninjurious take, external flipper-tagging, and taking of tissue samples of 32 sea turtles in any combination in association with any relocation trawling conducted during hopper dredging. Maintenance-dredging activities for the proposed project are covered by an existing agreement between the NMFS and USACE regarding the taking of sea turtles with hopper dredges to ensure that significant impacts do not occur (NOAA, 2003).

7.7 MIGRATORY BIRD TREATY ACT AND MIGRATORY BIRD CONSERVATION ACT

The Migratory Bird Treaty Act of 1918 (as amended) extends Federal protection to migratory bird species; among other activities, nonregulated "take" of migratory birds is prohibited under this Act in a manner similar to the ESA prohibition of "take" of threatened and endangered species. Additionally, EO 13186, "Responsibility of Federal Agencies to Protect Migratory Birds," requires Federal activities to assess and consider potential effects of their actions on migratory birds (including, but not limited to, cranes, ducks, geese, shorebirds, hawks, and songbirds). The effect of the Preferred Alternative on migratory bird species has been assessed. The USFWS has concurred that the Preferred Alternative is not likely to affect designated piping plover habitat at Louisiana Point. DMMP marsh restoration and Louisiana marsh mitigation areas would result in a net increase in migratory bird habitat in the project area. Construction contracts would include instructions to avoid impacts to migratory birds and their nests from construction-related activities. The Migratory Bird Conservation Act (16 USC 715–715d, 715e, 715f–715r; 45 Stat. 1222) establishes a Migratory Bird Conservation Commission to approve areas of land or water for acquisition as reservations for migratory birds and is not applicable to the project.

7.8 FISH AND WILDLIFE COORDINATION ACT OF 1958

The Fish and Wildlife Coordination Act directs Federal agencies to consult with the USFWS and relevant state wildlife resource agencies regarding potential impacts to wildlife from proposed improvements like the proposed SNWW CIP. The intent of this consultation is to help prevent the loss of and damage to wildlife resources from water development projects. USACE has consulted with the USFWS throughout the ICT process, and as a result, USFWS recommendations have been incorporated into the final impact assessment and the BU and compensatory mitigation plans for the Preferred Alternative. The USFWS submitted a Coordination Act Report (CAR) that affirms the USACE impact assessment and approves the proposed BU and mitigation plans. The CAR, dated March 16, 2010, is presented in Appendix A3.

7.9 NATIONAL WILDLIFE REFUGE SYSTEM IMPROVEMENT ACT OF 1997

The National Wildlife Refuge System Improvement Act of 1997 amended the National Wildlife Refuge System Administration Act of 1966 to improve management of the NWR System. An amendment to the 1966 Act requires that each refuge administrator review any proposed new use of a refuge to determine whether its use is compatible with the purposes of the refuge and consistent with public safety. Since the proposed Willow Bayou mitigation measures LA 2-18 and LA 2-ADD B are located in the Sabine NWR, and the proposed Gulf Shore BU Feature at Texas Point is located in the Texas Point NWR, the USACE has requested compatibility determinations from each refuge manager. Each refuge must identify the effects of the proposed use on refuge resources and provide an opportunity for public review and comment.

7.10 MARINE MAMMAL PROTECTION ACT OF 1972

The Marine Mammal Protection Act was passed in 1972 and amended through 1997. It is intended to conserve and protect marine mammals and establish the Marine Mammal Commission, the International Dolphin Conservation Program, and a Marine Mammal Health and Stranding Response Program. The Preferred Alternative is in compliance with this Act. No impacts to marine mammals are expected.

7.11 FISHERY CONSERVATION AND MANAGEMENT ACT OF 1996

Congress enacted amendments to the MSFCMA (PL 94-265) in 1996 that established procedures for identifying EFH and required interagency coordination to further the conservation of federally managed fisheries. EFH consists of those habitats necessary for spawning, breeding, feeding, or growth to maturity of species managed by Regional Fishery Management Councils in a series of Fishery Management Plans. Rules published by the NMFS (50 CFR sections 600.805–600.930) specify that any Federal agency that authorizes, funds, or undertakes, or proposes to authorize, fund, or undertake an activity that could adversely affect EFH is subject to the consultation provisions of the above-mentioned Act and identifies consultation requirements. Sections 3.10 and 4.11 of this FEIS were prepared to address EFH in the project area and to initiate consultation under the Act. Any detrimental impacts of the Preferred

Alternative on EFH are minor and temporary, but the project would provide indirect benefits since the project, including the DMMP restoration sites, would lead to an overall net gain in marsh habitat. The NMFS, by letter dated March 8, 2010, has concurred with the FEIS assessment of EFH impacts, and concurs that the proposed BU features and mitigation will offset the adverse impacts to EFH and provide a net-benefit to federally managed fisheries. No further consultation under the MSFCMA with NOAA or NMFS is required.

7.12 FEDERAL WATER PROJECT RECREATION ACT

The Federal Water Project Recreation Act of 1995 requires consideration of opportunities for outdoor recreation and fish and wildlife enhancement in planning water resource projects. The beneficial uses included in the project for the construction and maintenance material include uses requested by various recreational groups, environmental groups, and State and Federal regulatory agencies. All would benefit one or more of the items listed above.

7.13 MARINE PROTECTION, RESEARCH, AND SANCTUARIES ACT OF 1972

This Act requires a determination that dredged material placement in the ocean would not reasonably degrade or endanger human health, welfare, or amenities or the marine environment, ecological systems, or economic potential (shellfish beds, fisheries, or recreational areas). Maintenance and construction dredged material proposed for placement at the existing and new ODMDSs, designated by the EPA under Section 102 of Marine Protection, Research, and Sanctuaries Act (MPRSA), is subject to evaluation using the ocean dumping environmental criteria. The proposed new ODMDSs are outlined in Appendix B. The conclusion of the ODMDS Designation FEIS (Appendix B) was that the Preferred ODMDSs met all of the 5 general and 11 specific criteria listed in 40 CFR 228.5 and 228.6 and are therefore acceptable under the MPRSA. All material transported for ocean disposal would be evaluated pursuant to the EPA Ocean Dumping Regulations and Criteria (Section 103). Use of the ODMDSs would be in accordance with an approved Site Monitoring and Management Plan (SMMP).

7.14 COASTAL ZONE MANAGEMENT ACT

In an effort to encourage states to better manage coastal areas, Congress enacted the CZMA in 1972. Texas and Louisiana both have developed and continue to implement federally approved coastal zone management programs and plans (TCMP and LCMP, respectively). States with approved plans have the right to review Federal activities (including private activities that require Federal permits) to determine whether they are consistent to “the maximum extent practicable” with the policies of the state’s coastal zone management program. Appendix I addresses the compliance of the Preferred Alternative in this FEIS with the TCMP and LCMP in full detail.

In summary, CNRAs would be affected by the Preferred Alternative. The Preferred Alternative is a result of evaluating six project designs, several mitigation approaches, and beneficial uses of dredged material. Evaluations were made by the ICT and involved extensive modeling of ecological functions based on potential impacts, RSLR, and mitigative measures. The alternatives evaluations included attempts to minimize and avoid CNRAs to the maximum extent practicable and provide overall benefits to the ecosystems functions.

No net loss of coastal wetlands was a specific goal of the ICT and alternatives evaluation. Several components of the DMMP and mitigation plan involve restoration, protection, and enhancement of coastal wetlands. The Neches River BU Feature would restore 2,853 acres of emergent marsh, nourish 1,234 acres of existing marsh, and improve 871 acres of shallow-water habitat. Additionally, the mitigation plan consists of restoring five degraded marsh areas east of Sabine Lake near Willow and Black bayous, Louisiana. This mitigation measure would restore 2,783 acres of emergent marsh in existing open-water areas within the marsh, improve 957 acres of shallow-water habitat by creating shallower, smaller ponds and channels within the restored marsh, and stabilize and nourish 4,355 acres of existing adjacent marsh.

USACE has evaluated the proposed SNWW CIP for consistency with the Texas and Louisiana coastal management programs, and concluded that the Recommended Plan is fully consistent to the maximum extent practicable with the enforceable policies of both state programs. The Texas Coastal Coordination Council has concurred with the USACE consistency determination. The LDNR-OCM found that the SNWW CIP is conditionally consistent with their state program. Since conditional consistency as proposed by LDNR-OCM is not acceptable, LDNR-OCM has been notified that USACE will proceed with the project. This issue is discussed in further detail in Section 6.0.

7.15 COASTAL BARRIER IMPROVEMENT ACT OF 1990

This act is intended to protect fish and wildlife resources and habitat, prevent loss of human life, and preclude the expenditure of Federal funds that may induce development on coastal barrier islands and adjacent nearshore areas. The Coastal Barrier Improvement Act of 1990 was enacted to reauthorize the Coastal Barrier Resources Act (CBRA) of 1982. The Gulf shoreline at the Texas Point NWR is designated as an “otherwise protected area” (unit T01P). The Gulf shoreline in the Louisiana portion of the study area contains no CBRA-designated units. Exceptions to the Federal expenditure restrictions also include maintenance or constructed improvement(s) to existing Federal navigational channels and related structures (e.g., jetties), including the disposal of dredged materials related to maintenance and construction (The Center for Regulatory Effectiveness, n.d.); therefore, the Preferred Alternative is exempt from the prohibitions identified in the act.

7.16 FARMLAND PROTECTION POLICY ACT OF 1981 AND THE CEQ MEMORANDUM PRIME AND UNIQUE FARMLANDS

In 1980, the CEQ issued an Environmental Statement Memorandum “Prime and Unique Agricultural Lands” as a supplement to the NEPA procedures. Additionally, the Farmland Protection Policy Act was passed in 1981, requiring consideration of those soils, which the USDA defines as best suited for food, forage, fiber, and oilseed production, with the highest yield relative to the lowest expenditure of energy and economic resources. The NRCS concurred that the “prime farmland if drained” soil mapped in PA 24A is not Important Farmland, and provided the Farmland Conversion Impact Rating Form indicating an exemption.

7.17 EXECUTIVE ORDER 11988, FLOODPLAIN MANAGEMENT

The Preferred Alternative includes the development of two new PAs (PA18A and PA24) and the Neches River BU Feature within the floodplain of the Neches River. Alternatives to avoid the adverse effects of developing the two new PAs in the floodplain were evaluated, and it has been determined that this is the only practicable alternative. The Neches River BU Feature would construct marsh in areas of open water within the floodplain that formerly were emergent marsh; they would remain jurisdictional wetlands after construction. Development in the BU areas would be controlled by Section 404 regulations, and their construction would not be expected to induce growth in the floodplain. BU alternatives were evaluated in consideration of existing drainages to ensure that restored wetland areas would not induce flooding. This FEIS fulfills public notification requirements as it provides an explanation of why these project features are proposed to be located in the floodplain and provides an opportunity for the public to comment on these plans.

7.18 EXECUTIVE ORDER 11990, PROTECTION OF WETLANDS

This EO directs Federal Agencies to avoid undertaking or assisting in new construction in wetlands, unless no practical alternative is available. One of the two new PAs proposed for development (PA 24A) would result in the conversion of 86 acres of wetlands to a confined PA. Alternatives to avoid the loss of 86 acres of wetlands were evaluated, and it has been determined that this is the only practicable alternative. The Preferred Alternative’s Neches River BU Feature would result in a net gain in wetlands along the lower Neches River, and the ecological benefits of this feature would more than offset the loss of 86 wetland acres due to the construction of PA 24A. The Neches River BU Feature would construct marsh in areas of open water within the floodplain that formerly were emergent marsh; they would remain jurisdictional wetlands after construction. The Neches River BU Feature would improve water quality, inhibit erosion and sediment loss, and restore habitat for fish and wildlife species, improving the long-term productivity of the lower Neches River ecosystem.

7.19 EXECUTIVE ORDER 13112, INVASIVE SPECIES

Under EO 13112, Federal agencies may not authorize, fund, or carry out actions that it believes are likely to cause or promote the introduction or spread of invasive species unless the agency has determined and made public its determination that the benefits of such actions clearly outweigh the potential harm caused by invasive species. Related to project development and implementation, Federal agencies whose action(s) may affect the status of invasive species are required to use relevant programs, information, and authorities to do the following:

- prevent the introduction and/or spread of invasive species;
- accurately monitor invasive species populations related to their area of effects;

- provide restoration for natural vegetation communities adversely affected by invasive species;
- provide environmentally sound control of invasive species; and
- consult with the Invasive Species Council and ensure their actions are consistent with the Invasive Species Management Plan.

Although ship traffic would increase with the Preferred Alternative, the increase would be less than the predicted growth of ship traffic under the No-Action Alternative, and therefore, no additional impacts with respect to ballast water are expected. Furthermore, no changes in foreign ports of call are predicted.

7.20 EXECUTIVE ORDER 12898, ENVIRONMENTAL JUSTICE

This EO directs Federal agencies to determine whether the Preferred Alternative would have a disproportionate adverse impact on minority or low-income population groups within the project area. The Preferred Alternative would not significantly affect any low-income or minority population (Section 4.12).

7.21 COMPREHENSIVE ENVIRONMENTAL RESPONSE, COMPENSATION, AND LIABILITY ACT AND RESOURCE CONSERVATION AND RECOVERY ACT

The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 (as amended) was designed to help clean up the nation's inactive hazardous waste sites. There are a variety of different requirements included in this sweeping legislation. CERCLA also requires industries to disclose to their communities what hazardous substances they use and store. CERCLA authorized the EPA to remediate polluted sites; for this purpose it created Superfund to pay for site cleanups when there is no clear-cut responsible party. The EPA can also pursue potentially responsible parties to make them pay for response and remediation activities. Superfund, 40 CFR 302–310, authorized the EPA to respond to and remedy polluted sites and created Superfund to pay for site cleanups when a responsible party could not be identified.

The RCRA of 1976 (as amended) provides for comprehensive cradle-to-grave regulation of hazardous waste and authorizes environmental agencies to order the cleanup of contaminated sites. Since 1984, it has also called for the extensive regulation of underground storage tanks and the cleanup of contamination caused by leaking tanks. In addition, RCRA addresses the environmental problems associated with nonhazardous solid waste and encourages states to develop solid waste management programs, regulate solid waste landfills, and eliminate open dumps. Federal facilities are required to comply with Federal, State, and local regulations and requirements on solid and hazardous waste and underground storage tanks to the same extent as private parties. RCRA contains provisions on a number of other topics, such as resource recovery, used oil management and recycling, small town environmental planning, and plastic ring carriers. While most RCRA provisions focus on the protection of human health, its wide-ranging attempts to prevent, reduce and eliminate pollution have an obvious, if largely unstated, effect on wildlife protection as well.

These acts require the reporting of hazardous, toxic, and radioactive waste and prescribe specific handling and remediation requirements. A records search was performed to identify possible RCRA and CERCLA sites in or near the project area, and these are described in the FEIS. An evaluation of the potential for these sites to impact the proposed project was conducted, and yielded the following concern. Contaminant issues affecting PA 17 must be resolved by the non-Federal sponsor before the PA can be used as part of the preferred alternative. Alternative placement areas are available should this not be resolved in time for use.

7.22 FEDERAL AVIATION ADMINISTRATION – HAZARDOUS WILDLIFE ATTRACTANTS ON OR NEAR AIRPORTS

In accordance with FAA AC 150/5200-33 and the Memorandum of Agreement among the FAA, the USACE, and other Federal agencies (July 2003), the Preferred Alternative was evaluated to determine if proposed land uses could increase wildlife hazards to aircraft using public use airports in the study area. Potential attractants (four existing PAs) were found to be located between the 10,000-foot and 5-mile perimeters of the Southeast Texas Regional Airport in Beaumont, Texas. No new PAs would be constructed within the separation perimeters, and no change in land use is proposed in conjunction with the Preferred Alternative. USACE provided this information to the FAA, and concluded that continued use of the four existing PAs does not constitute a change in land-use and is compatible with airport operations.

7.23 TEXAS CHENIER PLAIN NATIONAL WILDLIFE REFUGE COMPLEX COMPREHENSIVE CONSERVATION PLAN

The Texas Chenier Plain NWR Complex is four units administered by the USFWS: Anahuac NWR, McFaddin NWR, Texas Point NWR, and Moody NWR. These units are located along the upper Texas Gulf Coast in Chambers, Jefferson, and Galveston counties. Only the Texas Point NWR is located within the SNWW study area. The Refuge Complex's aquatic habitats (open-water and near-shore Gulf habitats), freshwater to saline marshes, riparian habitats, coastal woodlots, rice fields, native prairies, cheniers and coastal beach, and dune habitats harbor over 300 bird species, 75 species of freshwater fish, and 400 species of salt and brackish water finfish and shellfish.

Long-term, large-scale alterations to the region—over 100,000 acres of coastal wetland loss in 25 years; loss and conversion of more than 99 percent of the historic tallgrass prairie along the Louisiana and Texas Gulf Coasts for agriculture, residential, and commercial uses; increases in nonnative plant and animal species; loss or severe restriction of freshwater and sediment inflows and increased saltwater intrusion; and ongoing threats from sea level rise and land subsidence—have prompted the USFWS to act to facilitate the long-term protection of natural resources in the region.

The Texas Chenier Plain National Wildlife Refuge Complex Comprehensive Conservation Plan (CCP) provides a 15-year vision to identify and propose solutions to significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants and the actions necessary to correct or mitigate such problems (USFWS, 2008a). The CCP has four goals: (1) conserve, enhance and restore the refuge's coastal wetlands to provide habitat for native fish and wildlife; (2) conserve, enhance and restore the refuge's coastal prairies and coastal woodlands to provide habitat for native fish and wildlife; (3) implement a comprehensive biological program to guide and support conservation effort for all native fish, wildlife, and plant species; and (4) work with others on a landscape level to address threats to natural biological diversity, ecological integrity, and environmental health on the Refuge Complex. Specific strategies will include habitat restoration, protection, and land acquisition from willing sellers.

The Preferred Alternative would impact the goals of the CCP by causing small increases in salinity and land loss, and related decreases in productivity within the intermediate, brackish, and saline marshes of the Texas Point NWR. However, losses quantified by the WVA model would be more than offset by gains from the regular beneficial use of dredged material for shoreline nourishment at Texas Point. This BU feature complies with another goal of the CCP—the restoration of sediment supply to the Gulf's nearshore littoral zone at Texas Point NWR through the beneficial use of dredged material. Other CCP goals (restoration of hydrology by reducing saltwater intrusion with rock weirs or earthen plugs in Texas Bayou, and using dredged material to restore mineral sediment to interior marsh) were thoroughly evaluated in the screening of BU and mitigation measures. Construction of rock weirs or earthen plugs at Texas Bayou were determined to be ineffective in reducing saltwater intrusion. The beneficial use of dredged material to restore interior marsh would be feasible, but the cost would exceed the Traditional Placement Plan. The latter goal could be pursued if a non-Federal sponsor offers to pay the incremental cost of construction. The SNWW CIP does not conflict with any of the refuge expansion goals of the Texas Point NWR.

7.24 SABINE NATIONAL WILDLIFE REFUGE COMPLEX COMPREHENSIVE CONSERVATION PLAN

The Sabine NWR is part of the Southwest Louisiana National Wildlife Refuge Complex, which also includes Cameron Prairie and Lacassine NWRs to the east within Cameron Parish, and Shell Keys NWR in Iberia Parish. Only the western portion of the Sabine NWR (portions of Unit 5, excluding Pool 3, Unit 6, and Unit 7) is located within the SNWW study area. The refuge contains a diversity of habitat including extensive coastal marshes and open water, wooded ridges and levees, canals, ponds, and bayous. The refuge provides habitat for many species of wildlife, including ducks, geese, alligators, muskrats, nutria, raptors, wading birds, shorebirds, blue crabs, shrimp, and finfish. It is one of the primary overwintering refuges for waterfowl in the Mississippi Flyway.

Overall, the greatest risk to fish, wildlife, plants, and their habitats in the Chenier Plain ecosystem is from extensive wetland habitat degradation and loss that has occurred over the past century. Wetlands in the Chenier Plain declined 16 percent from the mid-1960s to 1990. These habitat losses have led to commensurate impacts on wildlife populations, especially those dependent on wetlands. These losses have prompted the USFWS to implement a 15-year protection plan to facilitate wetland preservation and restoration, a most important wildlife conservation priority of the Gulf Coast ecosystem.

The CCP provides a 15-year vision to identify and propose solutions to significant problems that may adversely affect the populations and habitats of fish, wildlife, and plants and the actions necessary to correct or mitigate such problems (USFWS, 2008b). CCP primary goals include (1) maintaining, restoring, and enhancing unique coastal wetland habitats on the refuge to provide favorable conditions to improve species diversity and richness of migratory birds and native terrestrial and aquatic species; and (2) maintaining healthy and viable wildlife and fish populations on the refuge to contribute to the purpose for which it was established.

The Preferred Alternative would impact the first goal of the CCP by causing small increases in salinity and land loss, and related decreases in productivity within the intermediate, brackish, and saline marshes of the refuge. However, losses as quantified by the WVA model would be more than offset by gains from the regular beneficial use of dredged material for shoreline nourishment at Louisiana Point and other BU features associated with the project in Texas. In addition, it is proposed that two of the compensatory mitigation measures proposed for the SNWW CIP be located within the Sabine NWR. These measures would employ one of the management strategies recommended by the CCP—using dredged material to restore mineral sediment to emergent marsh in degraded areas of the refuge. In the long term, these mitigation areas would contribute to the restoration of habitat and maintenance of healthy fish and wildlife populations in the refuge.

7.25 TEXAS COASTWIDE EROSION RESPONSE PLAN

The Texas Coastwide Erosion Response Plan has identified several parts of the study area as "critical erosion areas" because of impacts to habitats and traffic safety from ongoing erosion, and has called for an increase in the beneficial use of dredged material from the SNWW project to help address these issues. The plan was developed as part of the CEPRA (GLO, 2004, 2005). The program has identified the Gulf shoreline between Texas Point and Sea Rim State Park as a critical erosion area. It attributes the erosion, in part, to a lack of sediment coming down the Sabine and Neches rivers, and the interruption of longshore sediment transport by the SNWW jetties. The CEPRA Plan recommends that long-term regional sediment management be utilized, along with highway realignment and beach dune restoration, to protect the important coastal evacuation route of SH 87 in Jefferson County. In Orange County, the CEPRA Plan calls for restoration of 9,400 acres of marsh in the Lower Neches River using dredged material to raise soil elevations in the former marsh areas that have become open water. The Preferred Alternative would address some of the ongoing problems by using maintenance material for shoreline nourishment at Texas Point and by restoring and nourishing approximately 5,000 acres of marsh in the Lower Neches River floodplain.

7.26 LOUISIANA COAST 2050

In Louisiana, the Coast 2050 is a comprehensive, ecosystem-based restoration plan, completed in 1998 to address coastal wetland loss throughout southern Louisiana. Planning involved Federal, State, and local entities, landowners, environmentalists, wetland scientists, and others in the development of an integrated, multiple-use approach to ecosystem management. A major funding source for these projects comes from the Federal CWPPRA. The SNWW is located in Region 4 of this plan.

The goals of Coast 2050 are to:

- Sustain coastal ecosystem with the essential functions and values of the natural ecosystem
- Restore the ecosystem to the highest practicable acreage of productive and diverse wetlands
- Accomplish this restoration through an integrated program that has multiple use benefits

In the Sabine Lake area, Coast 2050 strategies include:

- Maintain Sabine River inflow
- Beneficial use of dredged material for marsh creation
- Seasonally operated locks at the mouths of navigation channels to relieve salinity stress on marshes

Detailed strategies for specific areas are described in the Coast 2050: Toward a Sustainable Coastal Louisiana (LCWCR/WCRA, 1998). The USACE, New Orleans District, and LDNR prepared the *Louisiana Coastal Area Feasibility Study* to provide the necessary technical data required to implement the conceptual plan of the Coast 2050 document (USACE, 2004a). The Preferred Alternative would impact the first goal of the Coast 2050 Plan by causing small increases in salinity and land loss, and small decreases in productivity. However, these losses would be fully compensated by marsh restoration mitigation measures in the Willow and Black bayou watersheds.

7.27 LOUISIANA COASTAL AREAS ECOSYSTEM RESTORATION STUDY AND PLAN

The LCA Ecosystem Restoration Study (USACE, 2004a) documented the most critical human and natural needs of the endangered Louisiana coastal area, identified short- and long-term critical priorities, and recommended large-scale, long-term studies that were beyond the scope of that study. The eastern half of the SNWW study area is located in the western part of Region 4, the Chenier Plain. Without any preservation or restoration actions, the report predicted that Sabine Lake wetlands would continue to experience severe wetland deterioration and land loss due to increased salinity levels and marine influences from the SNWW and the GIWW, relative sea level change, tropical storms, oil and gas infrastructure, sediment reduction/vertical accretion deficit, and saltwater intrusion resulting from diminished freshwater inflow.

For Region 4 as a whole, existing rates of habitat loss are predicted to continue, resulting in the loss by 2050 of 9.8 percent of existing fresh marsh, 16.3 percent of intermediate marsh, 100 percent of saline marsh, and 33.3 percent of swamp habitat. Brackish marsh and open water are predicted to increase by 46.5 and 11.4 percent, respectively. This would reduce habitat diversity and result in a long-term loss of an estimated 37 square miles of land loss.

The LCA report did not recommend any near-term critical restoration features for congressional authorization or additional study in Region 4. While beneficial use of dredged material from the Calcasieu Channel is recommended for wetlands adjacent to that channel, no beneficial use projects are identified for the marshes along the eastern shore of Sabine Lake. A long-term, large-scale study of freshwater and sediment management in the Chenier Plain was recommended and this would include the portion of the SNWW study area east of Sabine Lake and the Sabine River. The Preferred Alternative does not include any features that would conflict with future restoration features. Impacts of the proposed project would be fully compensated by the marsh mitigation measures.

7.28 LOUISIANA'S COMPREHENSIVE MASTER PLAN

Louisiana has developed a coastal master plan that integrates planning for ecosystem restoration and hurricane protection in planning for a sustainable coast (LCPRA, 2007). The master plan establishes a clear set of priorities for comprehensive coastal protection in Louisiana. In the Chenier Plain, the plan notes that navigation channels and canals have allowed salt water to penetrate inland, destroying fringe marsh and impinging on freshwater lakes. The plan recommends the development of a new plan to develop appropriate measures to address these impacts. Portions of the plan that affect the SNWW study area are as follows. The Chenier Plain Freshwater and Sediment Management and Reallocation Plan suggests managing river and surface fresh water supplies to ensure availability of fresh water throughout the year. This management would also permit the delivery of fresh water to areas exposed to saltwater stress. It is suggested that the GIWW could be used as a conduit to distribute fresh water from the Atchafalaya River toward marshes to the west. The plan also seeks to maintain the integrity of freshwater resources by raising and fortifying selected portions of SH 82, installing segmented offshore breakwaters to protect the barrier shoreline, fortifying dredged material banks along the GIWW, and placing saltwater barriers on the SNWW to manage salinity levels. The plan recognizes that safe and efficient navigation must be maintained when implementing such a project. It suggests that a barrier could be operated periodically to manage saltwater intrusion events. Marsh restoration using dredged material from maintenance dredging of navigation channels is also recommended. In planning hurricane protection structures, the plan emphasizes nonstructural solutions such as flood insurance, elevating and retrofitting structures, and revising building codes. No structural solutions for hurricane protection are recommended for the study area. The State's Annual Plan would be the vehicle for presenting yearly scheduling and cost information about proposed projects. The Preferred Alternative does not include any features that would conflict with restoration priorities of this plan. Impacts of the proposed project would be fully compensated by marsh mitigation measures.

7.29 LOUISIANA COASTAL PROTECTION AND RESTORATION

In February 2008, the Louisiana Coastal Protection and Restoration Draft Technical Report was released for public review and comment (USACE, 2008a). The study was conducted as a joint effort of the Federal government and the State of Louisiana to investigate and integrate hurricane risk reduction and coastal restoration for south Louisiana. The purpose of the report is to describe the progress that the USACE has made in this effort, which is mandated by the Energy and Water Development Appropriation Act of 2006 and the Department of Defense, Emergency Supplemental Appropriations to Address Hurricanes in the Gulf of Mexico, and Pandemic and Influenza Act, 2006. Additional time would be needed for the USACE to complete the comprehensive hurricane analysis and design for south Louisiana due to engineering, environmental, and economic complexities. The Louisiana Coastal Protection and Restoration effort is closely tied to Louisiana's Comprehensive Master Plan discussed above. The report does not make recommendations for project authorizations, appropriations, or nongovernmental decisions. It describes methodologies used to perform the technical evaluation and the process used to engage stakeholders.

One of the most significant accomplishments is the development and application of numerical models that replicate hurricane surges and determine the statistical frequency of events along the entire Louisiana coast. This effort has vastly improved the ability of the USACE to evaluate hurricane threats along the northern Gulf coast, including storm surge and wave effects. The Louisiana Coastal Protection and Restoration effort also quantified the risk reduction benefits provided by wetlands. The Louisiana coast is divided into planning units that generally correspond to previously defined subregions. Planning Unit 4 corresponds to Region 4, the Chenier Plain.

Hurricane modeling determined that certain areas of the Gulf are more likely to experience higher-intensity storms. Southeastern Louisiana, Mississippi, and western Alabama were shown to have a higher probability of severe-storm occurrence than elsewhere along the Gulf. The probability of a hurricane greater than Category 2 on the Saffer-Simpson Scale hitting the Gulf coastline in the SNWW study area is 2 percent in any 1 year, half that of the highest probability zone (4 percent in any 1 year). Hurricane Rita is a close comparison to a 100-year storm based on size, intensity, and track. It produced a peak storm surge with an approximately 90-year return interval, compared to the 400-year storm surge of Hurricane Katrina. The Louisiana Coastal Protection and Restoration storm surge modeling projects that a water surface height in the SNWW study area (east of Sabine Lake) with a 100-year storm would range from 15 feet near the coast to 11 feet north of the GIWW near Orange, Texas. Storm surge effects would be felt in the Sabine River valley far north of the current study area. For a 400-year storm, water elevations would range from 19 feet near the coast to 12 feet north of the GIWW near Orange, Texas.

Planning Unit 4 Alternatives located within the SNWW study area are limited to two types: (1) construction of a 12-foot-high levee along the entire GIWW alignment, ending at the Sabine River: and (2) marsh restoration in the marshes east of Sabine Lake. The coastal restoration alternative includes marsh restoration in two areas that are proposed as compensatory mitigation measures for the SNWW CIP (LA 3-10R and LA 3-15). Coastal restoration scored relatively highly in minimizing environmental impacts but did not appear to be a cost-effective measure. The potential for channel deepening proposed in the Preferred Alternative was evaluated with HS modeling conducted for this study. The results of this analysis indicated there would be no significant increase in storm surge effects.

7.30 NORTH AMERICAN WATERFOWL MANAGEMENT PLAN

The purpose of the North American Waterfowl Management Plan (NAWMP, Plan Committee, 2004) is to sustain abundant waterfowl populations by conserving landscapes through partnerships that are guided by sound science. The 2004 Plan establishes a new 15-year horizon for waterfowl conservation in North America by assessing and defining needs, priorities, and strategies needed to promote waterfowl conservation in the twenty-first century. The SNWW study area is located in the Gulf Coastal Prairie, an area of continental significance to North American ducks, geese, and swans as it lies within the Central Flyway. The plan focuses on habitat conservation at a continental scale and identifies general objectives for habitat conservation in five key priority regions, including the Gulf Coast Prairie Region. The beneficial use of dredged material to restore degraded marshes is specifically identified as a habitat conservation strategy in this plan. The Preferred Alternative would contribute to plan goals with the restoration and nourishment of approximately 5,000 acres of emergent marsh in the Lower Neches River floodplain and regular shoreline nourishment at Texas and Louisiana Points.

8.0 ANY ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED SHOULD THE PREFERRED ALTERNATIVE BE IMPLEMENTED

The Preferred Alternative would result in minor adverse impacts to benthos and fish from dredging and placement of dredged material but these impacts are temporary. Although the SNWW channel is located primarily in Texas, large indirect impacts may occur due to small increases in salinity levels causing an increase in wetland loss and a decrease in biological productivity in aquatic habitats of both Texas and Louisiana. In Texas, 33,500 acres of intertidal marsh and swamp are expected to be indirectly impacted due to the slight salinity increase as a result of the proposed action. Biological productivity may be reduced over approximately 39,000 acres of tidal marsh and swamp in Texas, with the potential loss of 247 acres of emergent marsh, including 86 acres of fresh marsh that would be converted to an upland PA. Impacts in Louisiana may affect approximately 182,000 acres of tidal, emergent marsh, and potentially result in the loss of about 691 additional acres of marsh within the area of tidal influence. This includes 86 acres of wetland habitat that would be converted to an upland PA. The BU features and compensatory mitigation address wetland loss by restoring a total of 5,636 acres of emergent marsh, 1,828 acres of improved shallow-water habitat, and nourishing 5,589 acres of existing marsh, which more than compensates for wetland losses resulting from a small increase in salinity and enhances the long-term productivity of the study area's ecosystem.

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9.0 ANY IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES INVOLVED IN THE IMPLEMENTATION OF THE RECOMMENDED PLAN

The primary impact of the Preferred Alternative is an indirect impact associated with a small increase in salinity and an associated reduction in biological productivity over approximately 211,500 acres of intertidal marsh and swamps in Texas and Louisiana, and the potential resultant loss of about 691 acres of marsh within the area of tidal influence of the SNWW. Benefits of the Neches River BU Feature more than offset the direct impact of conversion of 86 acres of fresh marsh to a confined PA (PA 24A) and the indirect impact of the increase in salinity over 39,000 wetland acres in Texas. The Neches River BU Feature restores 2,853 acres of emergent marsh, improves 871 acres of shallow-water habitat, and nourishes 1,234 acres of existing marsh, providing benefits that offset all project impacts in Texas and all but the loss of 843 AAHUs in Louisiana. The indirect effect of a small increase in Gulf shoreline erosion in both states (totaling approximately 15 acres over the period of analysis) is minimized by the Gulf Shore BU Feature. Compensatory mitigation for unavoidable impacts in Louisiana restores 2,783 acres of emergent marsh, improves 957 acres of shallow-water habitat, and nourishes 4,355 acres of existing marsh in the Willow and Black bayou areas. The BU features and compensatory mitigation address wetland loss by restoring 5,636 acres of emergent marsh, 1,828 acres of shallow-water habitat, and nourishing 5,589 acres of existing marsh, which more than compensates for worst-case wetland losses resulting from a small increase in salinity and enhances the long-term sustainability of the study area ecosystem. Since there would be a time lag before the restored marshes become established and ecologically functional, there would be a temporary loss of productivity during the interim period. Benthic organisms in the Gulf that are buried during initial and subsequent use of the ODMDSs would recover quickly after each use. The productivity of expanded PAs on the Neches River and the Sabine Lake bottom taken for borrow material would be temporarily disrupted, but would shortly be transformed into different habitats that would contribute to the long-term productivity of the SNWW estuary.

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10.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USES OF MAN'S ENVIRONMENT AND THE MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

BU features and compensatory mitigation provided under the Preferred Alternative address wetland loss by restoring 5,636 acres of emergent marsh, 1,828 acres of shallow-water habitat, and nourishing 5,589 acres of existing marsh, which more than compensates for worst-case wetland losses resulting from a small increase in salinity and enhances the long-term productivity of the study area ecosystem. Since there would be a time lag before the restored marshes become established and ecologically functional, there would be a temporary loss of productivity during the interim period. Benthic organisms in the Gulf that are buried during initial and subsequent use of the ODMDSs would recover quickly after each use. The productivity of expanded PAs on the Neches River and the Sabine Lake bottom taken for borrow material would be temporarily disrupted, but would shortly be transformed into different habitats that would contribute to the long-term productivity of the SNWW estuary.

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11.0 ENERGY AND NATURAL OR DEPLETABLE RESOURCE REQUIREMENTS AND CONSERVATION POTENTIAL OF VARIOUS ALTERNATIVES AND MITIGATION MEASURES

NEPA regulations in 40 CFR 1502.16(e) and (f) require a discussion of project energy requirements and natural or depletable resource requirements, along with conservation potential of alternatives and mitigation measures in an EIS.

Under the No-Action Alternative, the energy requirements for maintaining the channel would continue as before. However, the navigation requirements for energy (fuel) to transport commercial products is likely to increase in the future as commerce increases and more traffic increases congestion and navigation time into and out of regional ports. Air quality impacts are likely to increase with an increase in navigation traffic congestion and travel time along the SNWW.

The Preferred Alternative is expected to reduce energy (fuel) requirements for transporting products on a ton/mile basis by deepening the channel and providing bend easings:

- ships can be more heavily loaded with cargo; and
- fewer vessel trips would be required in lightering of crude oil from large ships offshore.

Energy (fuel) would be required to deepen the channel, but this is a short-term impact. Energy to maintain the deeper channel is expected to increase by roughly a factor of two, with the increase in shoal material expected for the larger channel. This increase in fuel requirement is expected to be more than offset by fuel savings in ship traffic in the larger channel and should help reduce air quality impacts slightly over the No-Action Alternative, especially since the largest increase in shoaling is offshore. Increased efficiency in moving petroleum and other petroleum-based commodities to the local refineries is expected to help conserve natural or depletable resources in the future. The reduced energy requirements of the more-efficient channel would result in a smaller increase in transportation costs in the future, which reduces overall production costs for the consumer.

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12.0 LIST OF AGENCIES AND ORGANIZATIONS TO WHOM COPIES OF THE FINAL STATEMENT ARE SENT

12.1 PUBLIC INVOLVEMENT PROGRAM

The USACE and SNND involved the public through public meetings and other outreach throughout the history of this project. A proactive approach was taken to inform and involve the public, resource agencies, industry, local government, and other interested parties about the project and to identify any public concerns.

The first public scoping meeting was held on May 24, 2000, at the John Gray Center Auditorium, Lamar University, Beaumont, Texas. The purpose of this meeting was to inform the public about the initiation of the feasibility study and to solicit comments on navigation concerns, alternatives to be addressed, and environmental issues and concerns.

The second public scoping meetings were held on May 28, 2002, at the Best Western Hotel, Lake Charles, Louisiana, and May 29, 2002, at the John Gray Center Auditorium, Lamar University, Beaumont, Texas. The purpose of these meeting were to inform the public about study progress and to solicit comments on environmental issues such as changes in salinity and circulation, changes in fresh- and saltwater marshes, water and sediment quality, erosion along the channel, threatened and endangered species impacts, and beneficial use of dredged materials.

Other various forms of outreach utilized during this project included early regulatory agency coordination, ICT, RW, MW, CW, OW, and HW meetings, public workshop to obtain ideas for BU of dredged material, media trips down the waterway, presentations at the GMFMC Texas Habitat Protection Advisory Panel, meetings with the Sabine Pilots Association, presentation at the 2007 Southeast Texas Leaders meeting, meetings with SNWW industries, individual contacts, press releases, and comment forms.

DEIS Public Hearings were conducted on January 26, 2010, at the Beaumont Civic Center in Beaumont, Texas, and on January 27, 2010, at the Lake Charles Civic Center in Lake Charles, Louisiana, to solicit comments and information from the public. Approximately 51 people attended the meeting in Beaumont, and 19 in Lake Charles. An open house was conducted prior to the Public Meetings, which included table-top poster presentations and discussions among the USACE, the SNND, USACE consultants, and the public. Formal presentations were made by SNND and USACE during the public meetings, and then oral comments were taken from the public. These comments were considered when finalizing the FEIS. Transcripts of the DEIS public meetings are presented in Appendix K.

12.2 REQUIRED COORDINATION

The FEIS is being circulated to all known Federal, State, and local agencies. Interested organizations and individuals are also being sent notice of availability. A list of those who are being sent a copy of this document, along with a request to review and provide comments on the documents, is provided in Section 12.3.

12.2.1 PUBLIC VIEWS AND RESPONSES

Public views and concerns expressed during this study have been considered during the preparation of this FEIS. The views and concerns were used to develop planning objectives, identify significant resources, evaluate impacts of various alternatives, identify potential PAs, and identify a plan that is socially and environmentally acceptable. Important concerns expressed included the beneficial use of dredged material and recreational opportunities.

Development of alternatives is explained in Section 2. The recommended plan takes into consideration the expressed objectives, views, and concerns of the resource agencies and public. Public comments received are addressed Appendix A5.

12.3 STATEMENT RECIPIENTS

The following list includes agencies, organizations, and public that were sent a copy of these documents and/or the Notice of Availability with a request to review and provide comments.

Organizations

Bill Bass
Coastal Conservation Association-Acadiana
P.O. Box 3527
Lafayette, LA 70502

David Bezanson
The Nature Conservancy
816 Congress, #920
Austin, TX 78701

Charles Bollich
Texas Archeological Stewardship Network
5795 Viking Dr.
Beaumont, TX 77706

Lowell Boudreaux
Lamar University
P.O. Box 10025
Beaumont, TX

Winnie Burkett
Houston Audubon Society
919 Layfair Place
Friendswood, TX 77546

Raymond Butler
Gulf Intracoastal Canal Association
2010 Butler Drive
Friendswood, TX 77546

David Corban
Fulbright & Jaworski, L.L.P.
Fulbright Tower, 1301 McKinney, Suite 5100
Houston, TX 77010-3095

Mark Davis
Coalition to Restore Coastal Louisiana
6160 Perkins Road, Suite 225
Baton Rouge, LA 70808

Sherri Droddy
Sabine Pass Port Authority
P.O. Box 318
Sabine Pass, TX 77655

Kenneth Duhon
Navigation District
8174 Boyt Rd.
Beaumont, TX 77713

Lee Elliot
Texas Audubon Society
205 N. Carrizo Street
Corpus Christi, TX 78401-3033

Paul Fontenot
Sierra Club - Acadiana Group
120 Rue Du Jardin
Lafayette, LA 70507-4843

Mike Foster
South East Texas Regional Planning Commission
2210 Eastex Freeway
Beaumont, TX 77703

Cynthia Goldberg
Gulf Restoration Network
P.O. Box 2245
New Orleans, LA 70176

Richard Harrel
Clean Air & Water
750 Wade
Beaumont, TX 77706

Captain Charles Lahaye
Sabine Pilots Association
5148 W. Parkway
Groves, TX 77619

Rick Jacob
Nature Conservancy of Louisiana
3923 Marie Court
Lake Charles, LA 70607

Larry E. Kelly
Toledo Bend Reservoir, Sabine Parish
210 Hillcrest Drive
Anacocco, LA 71403

Jack Lawrence
Clean Air and Water
5570 Winfree
Beaumont, TX 77705

Bruce Lockett
Texas Archaeological Studies Association
P.O. Box 905
Vidor, TX 77602

Brandt Mannchen
Sierra Club-Lone Star Chapter
5431 Carew
Houston, TX 77096

Richard Martin
Nature Conservancy of Louisiana
P.O. Box 4125
Baton Rouge, LA 70821

Charles McGimsey
University of Southwestern Louisiana, Department of Sociology-Anthropology
P.O. Box 40198
Lafayette, LA 70504

Ehab Meselhe
University of Louisiana at Lafayette, Civil Engineering Department
Abdalla Hall, Room 126
Lafayette, LA 70504-2347

Gretchen Mueller
Audubon Society-Houston
440 Wilchester
Houston, TX 77079

Jerry Norris
Sabine Lake Guide Service
3262 Bell Street
Port Arthur, TX 77640

Todd Brindle
Big Thicket National Preserve, Superintendent
6044 FM 420
Kountze, TX 77625

Steven Peyronnin
Coalition to Restore Coastal Louisiana
6160 Perkins Road, Suite 225
Baton Rouge, LA 70808

Lisa F. Regan
Texas Energy Coalition
6207 Inwood Drive
Houston, TX 77057

Denis Calabrese
Texas Energy Coalition
6207 Inwood Drive
Houston, TX 77057

Cynthia Sarthou
Gulf Restoration Network
P.O. Box 2245
New Orleans, LA 70176

Diane Schenke
The Nature Conservancy Texas City Prairie Preserve
4702 Hwy 146 N
Texas City, TX 77590

Harold Schoeffler
Sierra Club-Acadian Group
P.O. Box 2218
Lafayette, LA 70502

Bruce Sieve
Sierra Club-Groves
4949 Main Ave.
Groves, TX 77619

Ryan Smith
Texas Energy Museum
600 Main Street
Beaumont, TX

Wayne Stupka
Gulf Coast Rod Reel and Gun Club
P.O. Box 8057
Lumberton, TX 77657

Melvin Swoboda
East Texas Regional Water Planning Group
P.O. Box 1089
Orange, TX 77631-0579

Ken Sztraky
Audubon Society-Golden Triangle
P.O. Box 1292
Nederland, TX 77627-1292

Carolyn Thibodeaux
Cameron Preservation Alliance-Sabine Lighthouse, Inc.
P. O. Box 773
Cameron, LA 70631

Louis Trahan
Audubon Society-Acadiana Chapter
707 E. Simcoe St
Lafayette, LA 70501-4524

Rebecca Triche
Coalition to Restore Coastal Louisiana
6160 Perkins Road, Suite 225
Baton Rouge, LA 70808

Captain Charles A. Tweedel
Sabine Pilots Association
5148 West Parkway Drive
Groves, TX 77619

John Whittle
Audubon Society - Golden Triangle
3015 Nashville Ave.
Nederland, TX 77627

John Wesley Paul
Golden Triangle Sierra Club, Conservation Chair
13005 Beaverbrook Street
Lumberton, TX 77657

Gina Donovan
Audubon Society-Houston
440 Wilchester
Houston, TX 77079

Captain Michael Egan
Sabine Pilots Association
5148 W. Parkway
Groves, TX 77619

Don Gohmert
Natural Resources Conservation Service
101 S. Main
Temple, TX 76501

Randy Reese
Navigation District
P.O. Box 778
Nederland, TX 77627

Natalie Snider
Coalition to Restore Coastal Louisiana
6160 Perkins Road, Suite 225
Baton Rouge, LA 70808

Patrick Nugent
Texas Pipeline Association, Executive Director
604 West 14th Street
Austin, TX 78701

Coastal Conservation Association-Louisiana Chapter
P.O. Box 373
Baton Rouge, LA 70821-0373

Coastal Conservation Association-Texas Chapter
6919 Portwest, Suite 100
Houston, TX 77024

The Nature Conservance of Texas
P.O. Box 1440
San Antonio, TX 78295-1440

The Nature Conservancy of Louisiana
P.O. Box 4125
Baton Rouge, LA 70821

Local Government

Morris Albright
Chamber - Port Arthur
4749 Twin City Hwy. Suite 300
Port Arthur, TX 77642-5839

Everett Alfred
Jefferson County Commissioner
Precinct 4
7780 Boyt Road
Beaumont, TX 77713

Becky Ames
Mayor of Beaumont, Texas
801 Main Street
Beaumont, TX 77704

Francis Andrepont
Calcasieu Parish Police Jury
District 13
1302 Fatima
Sulphur, LA 70663

Eddie Arnold
Jefferson County Commissioner
Precinct 1
1149 Pearl Street, 4th Floor
Beaumont, TX 77701

Brad Bailey
Mayor of Groves, Texas
3947 Lincoln Ave.
Groves, TX 77619

Nancy Beaulieu
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

Guy Brame
Calcasieu Parish Police Jury
District 8
1908 Linden Lane
Lake Charles, LA 70605

Kirk Burleigh
Cameron Parish Police Jury
District 6
P.O. Box 576
Cameron, LA 70631

Owen Burton
Orange County Commissioner
Precinct 2
123 South 6th Street
Orange, TX 77630

W. Brown Claybar
Mayor of Orange, Texas
803 W. Green Ave.
Orange, TX 77630

Cindy Clifton
Chamber – Nederland
P.O. Box 891
Nederland, TX 77627

Dr. Alan B. Coleman
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

Calvin Collins
Calcasieu Parish Police Jury
District 2
2035 Woodring Street
Lake Charles, LA 70601

Brad Corley
Chamber – Groves
4399 Main Ave.
Groves, TX 77619

Daniel Cupit
Mayor of Westlake, Louisiana
1001 Mulberry Street
Westlake, LA 70669-4523

Jimmy Dike
Pleasure Island Commission
520 Pleasure Pier Boulevard
Port Arthur, TX 77640

Mark Domingue
Jefferson County Commissioner
Precinct 2
7759 Viterbo Road, Suite 1
Beaumont, TX 77705

David Dubose
Orange County Commissioner
Precinct 1
123 South 6th Street
Orange, TX 77630

John Dubose
Orange County Commissioner
Precinct 3
123 South 6th Street
Orange, TX 77630

Christopher Duque
City of Nederland - City Manager
P.O. Box 967
Nederland, TX 77627-0967

Les Farnum
Calcasieu Parish Police Jury
District 15
312 Oakley Drive
Sulphur, LA 70663

Darryl Farque
Cameron Parish Police Jury
District 7
10690 Hwy. 384
Lake Charles, LA 70607

Steve Fitzgibbons
City of Port Arthur
P.O. Box 1089
Port Arthur, TX 77641

Becky Ford
Mayor Bevil Oaks, Texas
7390 Sweetgum Road
Beaumont, TX 77713

Sabrina Grey
Greater Orange Area Chamber of Commerce
1012 Green Avenue
Orange, TX 77630

Elizabeth Griffin
Calcasieu Parish Police Jury
District 3
903 North Jake Street
Lake Charles, LA 70601

Kevin Guidry
Calcasieu Parish Police Jury
District 9
4045 Briarfield Lane
Lake Charles, LA 70607

Terri Hanks
City of Port Arthur
P.O. Box 1089
Port Arthur, TX 77641-1089

Ellis Hassien
Calcasieu Parish Police Jury
District 12
4349 Pete Seay Road
Sulphur, LA 70665

Kyle Hayes
City of Beaumont - City Manager
801 Main Street, Suite 300
Beaumont, TX 77701

Glenn Johnson
Mayor of Port Neches, Texas
P.O. Box 758
Port Neches, TX 77651

Phil Kelly
Jefferson County Drainage District No. 7
P.O. Box 3244
Port Arthur, TX 77642

Chris Landry
Calcasieu Parish Police Jury
District 7
4336 Oaklawn
Lake Charles, LA 70605

Ronald Lelux
Mayor of Sulphur, Louisiana
101 N. Huntington St.
Sulphur, LA 70663

Dr. Charles Mackey
Calcasieu Parish Police Jury
District 5
1215 9th Street
Lake Charles, LA 70601

Thomas McDaniel
Cameron Parish Police Jury
District 4
P.O. Box 274
Creole, LA 70632

Mangus McGee
Cameron Parish Police Jury
District 1
121 Alvin Lane
Cameron, LA 70631

Hal McMillin
Calcasieu Parish Police Jury
District 14
1423 N. Beech Street
Westlake, LA 70669

S. Mark McMurry
Calcasieu Parish Police Jury Administrator
1015 Pithon Street, 2nd Floor
Lake Charles, LA 70602

Randy Miller
Imperial Calcasieu Regional Planning & Development Commission
P.O. Box 3164
Lake Charles, LA 70602

Beamon Minton
Orange County Commissioner
Precinct 4
123 South 6th Street
Orange, TX 77630

R.A. "Dick" Nugent
Mayor of Nederland, Texas
P.O. Box 967
Nederland, TX 77627

Shawn Oubre
City of Orange - City Manager
P.O. Box 520
Orange, TX 77630

Jose Pastrana
Jefferson County Engineer
1149 Pearl Street, 5th Floor
Beaumont, TX 77701

W.L. Pate, Jr.
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

James Porter
Imperial Calcasieu Regional Planning & Development Commission
P.O. Box 3164
Lake Charles, LA 70602

Charles Prect
Cameron Parish Police Jury
District 3
159 W. Precht Rd.
Sweet Lake, LA 70630

Deloris "Bobbie" Prince
Mayor of Port Arthur, Texas
P.O. Box 1089
Port Arthur, TX 77641

Steve Racca
Cameron Parish Police Jury
District 2
478 Myers Rd.
Hackberry, LA 70645

Mary Ann Reid
Chamber - Port Arthur
4749 Twin City Hwy. Suite 300
Port Arthur, TX 77642-5839

Jim Rich
Beaumont Chamber of Commerce
1110 Park Street
Beaumont, TX 77701

Randy Roach
Mayor of Lake Charles, Louisiana
326 Pujo Street, 10th Floor
Lake Charles, LA 70601

Kirk Roccaforte
Mayor of Bridge City, Texas
260 Rachal Drive
Bridge City, TX 77611-0846

Audwin M. Samuel
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

Dennis Scott
Calcasieu Parish Police Jury District 6
5733 Bennie Lane
Lake Charles, LA 70605

Michael Sinegal
Jefferson County Commissioner Precinct 3
525 Lakeshore Dr.
Port Arthur, TX 77640

Jamie D. Smith
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

Shannon Spell
Calcasieu Parish Police Jury District 1
2296 Pinon
Lake Charles, LA 70611

Tony Stelly
Calcasieu Parish Police Jury District 10
Post Office Box 439
Iowa, LA 70647

Kenneth Stinson
Mayor of Vinton, Louisiana
1200 Horridge Street
Vinton, LA 70668

David Studdert
Mayor of Nome, Texas
P.O. Box D
Nome, TX 77629

George Swift
Chamber of Commerce for Southwest Louisiana
P.O. Box 3110
Lake Charles, LA 70602-3110

Claude Syas
Calcasieu Parish Police Jury District 4
2506 13th Street
Lake Charles, LA 70601

Carl Thibodeaus
Orange County Judge
123 South 6th Street
Orange, TX 77630

Scott Trahan
Cameron Parish Police Jury District 5
PO Box 235
Creole, LA 70632

Sandra Treme
Calcasieu Parish Police Jury District 11
920 Overton
DeQuincy, LA 70633

Ronald Walker
Jefferson County Judge
1149 Pearl Street
Beaumont, TX 77701

Fred Jackson
Jefferson County Courthouse
1149 Pearl Street, 4th Floor
Beaumont, TX 77701

John Walker
Mayor of China, Texas
P.O. Box 248
China, TX 77613

Kenneth Williams
City of Nome
P.O. Box D
Nome, TX 77629

Gethrel Williams-Wright
City of Beaumont
P.O. Box 3827
Beaumont, TX 77704

André Wimer
City of Port Neches - City Manager
P.O. Box 758
Port Neches, TX 77651

Cameron Parish Chamber of Commerce
433 Marshall Street
Cameron, LA 70631

Jefferson County
1149 Pearl Street
Beaumont, TX 77701-3619

Nederland Chamber of Commerce
1515 Boston Ave
Nederland, TX 77627

Port Arthur Chamber of Commerce
4749 Twin City Highway, Suite 300
Port Arthur, TX 77642

Port Neches Chamber of Commerce
P.O. Box 445
Port Neches, TX 77651

Myles Hebert
Coastal Zone Administrator, Flood plain Administrator and Chief Building Official
P.O. Box 1280
Cameron, LA 70631

Fred Jackson
Jefferson County Judge's Office
1149 Pearl, 4th Floor
Beaumont, TX 77701

Taylor Shelton
City of Port Neches
P.O. Box 758
Port Neches, TX 77651

Libraries

Kun-Woo Choi
Elmo Willard Library
3590 East Lucas
Beaumont, TX 77701

Library Director
City of Orange Public Library
220 N. 5th Street
Orange, TX 77630

Library Director
Marion & Ed Hughes Public Library
2712 Nederland Ave.
Nederland, TX 77627

Jose Martinez
Port Arthur Public Library
4615 9th Avenue (at Highway 73)
Port Arthur, TX 77642

Mary Montgomery
Bridge City Public Library
101 Parkside Drive
Bridge City, TX 77611

Gwendolyn Pierre
Theodore Johns Branch Library
4255 Fannett
Beaumont, TX 77701

Geri Roberts
Beaumont Public Library
801 Pearl
Beaumont, TX 77701

Michael Sawyer
Calcasieu Parish Public Library
301 W. Claude Street
Lake Charles, LA 70605

Jim Shoemaker
R. C. Miller Library
1605 Dowlen
Beaumont, TX 77701

Consultants

Chris Claunch
Shiner Moseley & Assoc.
3300 S. Gessner #111
Houston, TX 77063

Ed Fike
Coastal Environments, Inc.
1260 Main St.
Baton Rouge, LA 70802

General Public

American Eagle
American Press
Ameripol Synpol Corporation
Chief Michael Amos
Donnie Ancelet
Leslie Appelt
Eddie Arnaud
Lawrence Aten
AtoFina
D. Babin
Greg Baehr
Curtis Baker
Scott Bare
Delores Barnhill
Barbara Batty
Larry Beaulieu
Rodney Begnaud
James Bel
Regina Bell
Braxton Bennett
Deodat Bhagwandin
Gene Bouillion
Thomas Brent
Rickey P. Brouillette
Rene Broussard
Richard Bryan
Hermie Bundick
Ralph Burch
Tom Burger
Dwayne Burton
Marty Byrd
Clifton Cabell
James Cacioppo
Kim Carroll
Steve Carroll
Centana Intrastate Pipeline
Dan Chand
Citgo Pipeline Company
Dickie Colburn
Henry Combs
Todd Connel
David Conner
Bruce Connery
Bobby Cooper
Jayme Cox
Crain Brothers Inc.
Bryan Crismon
Bucky Crisp
Catherine Cunningham
Kelly Cupero
DCP Midstream, LLC
Susan Davenport
Anne Demuth
Byron DePrang
Jere Dial
Don Dodd
William Doré
Gina Dorsey
Keith Dosch
Melvin Douglas
Ducks Unlimited Texas Field Office
Dunan Entergy Partners, L.P.
Eugene E. Durand
John Durkay
E.I. DuPont de Nemours
Econo Rail Corp
Jim Ephraim
FOCC (Refinery)
George Fereday
David Fisher
Chris Fisher
Delbert Fore
Billy Fortier
Johnny Frederick
Grant Freund
Paul Friesema
Ginger Funk
Sherwood Gagliano
Phil Gamble
George Gardner

Floyd Gaspard
James Gentz
Great Lakes Carbon
Glenn Green
Gulf South Pipeline Company, L.P.
Donald Hall
Neil Harrison
Michael Heim
Carl Henderson
Michael Hluza
Donald Hofer
Don Hofer
T. Hooks
George Horton
Cecil Howard
Tim Huffer
I.M. Skaugen SE
Investa, B.V.
Kathleen Jackson
Skip James
David Janwich
Raymond Johnson
Roy Johnson
Stan Johnson
Justin Jones
Raymond Jordan
Ron Joseph
James Kaucher
Lori Keeter
George Kelly
Bill Kimbrough
Gary King
Jim King
John Knippa
James Krohe
Kudu Limited II, Inc.
Mary LaBlanc
Lake Charles American Press
Tom Lassiter
Matt Long
Susan Ludwig
Fred Manhart
Josh Martin
Linda Mathews
Masao Mayorga
Lynn McCall
David McMasters
Karen McMillin
Chris T. McPike
Jake Messina
Military Sealift
Frederic Miller
Ike Mills
Stephen Mills
Julea Mitchell
Mobile Oil Corp
Ronald Moon
Dennis Moon
Motiva Enterprises, LLC
Charles Nelson
C. Newell
Patrick Nwakoby
Richard Osburn
Jerry Outremari
Hubert Oxford
Hubert Oxford, III
Hubert Oxford, IV
Panhandle Eastern Corp
Clay Pelloat
David Petty
Vernon Pierce
Ervin Polnick
Port Arthur News
Port City Petroleum, Inc.
Premcor
Darryl Reed
Miles Resnick
Randy Richard
David Richard
Gordon Ricossa
G. Grant Roane
Captain Robinson
James Robinson
John Roby
Catherine Rourke
Steve Russell
Sherrill Sagrera
Andre' Says
Terry Schwertner
Dick/Bill Scott
Pete Shelton
Linda Sickels
Allen Sims
Bryan Speaght
Ted Springs
Hunt Sproull
Daniel Stahl
Mike Stafford
Bill Stanisfer
Hercel Stracener
Philip Stock
Dave Suter
Stephen Swetish
Joe Sydes
TPC Group, Inc.
Arthur Thomas
Cathy Thornton
Collin Thorp
Dennis Tindall
Gabriel Trevino
Robert Troxell
James Tucker
Keith Tyree
Jim Uncapher
Mark Underhill
Unocal
Chuck Uzzle
Vastar Resources, Inc.
Rusty Vincent
Dan Wallach
Aubrey Webb
Donna Weifenbach
Milton Westbrook
Jim Westgate
Michael Weston
Bernard Wheeler
Sam Whitehead
Wayne Wilbur
Melinda Winn
Rick Williams
Lester Winfree
Albert Zipp
Julia Zolandz

State Representatives

Honorable Charles Boustany
United States Senator
1117 Longworth House Office Building
Washington, DC 20515-1807

Charles Boustany
U.S. House of Representatives, 7th District of Louisiana
Capital One Tower, One Lakeshore Drive Ste. 1135
Lake Charles, LA 70629

Kevin Brady
U.S. House of Representatives, 8th District of Texas
301 Cannon House Office Building
Washington, DC 20515

Kevin Brady
U.S. House of Representatives, 8th District of Texas
420 Green Ave,
Orange, TX 77630

Honorable John Cornyn
United States Senator
517 Hart Senate Office Building
Washington, DC 20510

Honorable John Cornyn
United States Senator
5300 Memorial Drive, Suite 980
Houston, TX 77007

Michael Danahay
Louisiana State Representative, District 33
1625 Beglis Parkway
Sulphur, LA 70663

Michael Danahay
Louisiana State Representative, District 33
P.O. Box 44486
Baton Rouge, LA 70804-4486

Michael E. Danahay
Louisiana State Representative, District 33
1625 Beglis Pkwy.
Sulpher, LA 70663

Joseph Deshotel
Texas State Representative District 22
P.O. Box 2910
Austin, TX 78768

Joe Deshotel
Texas State Representative District 23
One Plaza Square, Suite 203
Port Arthur, TX 77642

Brett Geyman
Louisiana State Representative, District 35
P.O. Box 12703
Lake Charles, LA 70612-2703

Brett Geyman
Louisiana State Representative, District 35
P.O. Box 44486
Baton Rouge, LA 70804-4486

Garrett Graves
Governor's Office of Coastal Activities
Capitol Annex 1051 N. 3rd Street, Suite 138
Baton Rouge, LA 70804

Al Green
U.S. House of Representatives, 9th District of Texas
3003 South Loop West, Suite 460
Houston, TX 77054

Mike Hamilton
Texas State House of Representatives District 19
P.O. Box 2910
Austin, TX 78768

Mike Hamilton
Texas State House of Representatives District 19
P.O. Box 119
Mauriceville, TX 77626

Dorthy Sue Hill
Louisiana State Representative, District 32
529 Tramel Rd.
Dry Creek, LA 70637

Joan Huffman
Texas State Senator, District 17
6217 Edloe
Houston, TX 77005

Joan Huffman
Texas State Senator, District 17
P.O. Box 12068, Capitol Station
Austin, TX 78711

Honorable Kay Hutchison
United States Senator
284 Russell Senate Office Building
Washington, DC 20510-4304

Honorable Kay Hutchison
United States Senator
1919 Smith Street, Suite 800
Houston, TX 77002

Chuck Kleckley
Louisiana State Representative, District 36
130 Jamestown Rd.
Lake Charles, LA 70605

Honorable Mary Landrieu
United States Senator
328 Hart Senate Office Building
Washington, DC 20510

Honorable Mary Landrieu
United States Senator
Capital One Tower, One Lakeshore Drive Ste. 1260
Lake Charles, LA 70629

Dan Morrish
Louisiana State Senate, District 25
119 W. Nezpique Street
Jennings, LA 70546

Dan Morrish
Louisiana State Senate, District 25
P.O. Box 94183
Baton Rouge, LA 70804

Ms. Willie Mount
Louisiana State Senate, District 27
P.O. Box 94183
Baton Rouge, LA 70804

Ms. Willie Mount
Louisiana State Senate, District 27
P.O. Box 3004
Lake Charles, LA 70602

Jonathan Perry
Louisiana State Representative, District 47
407 Charity Street, Suite 102
Abbeville, LA 70501

Jonathan Perry
Louisiana State Representative, District 47
P.O. Box 44486
Baton Rouge, LA 70804-4486

Ted Poe
U.S. House of Representatives, 2nd District of Texas
301 Cannon House Office Building
Washington, DC 20515

Ted Poe
U.S. House of Representatives, 2nd District of Texas
505 Orleans Street, Suite 100
Beaumont, TX 77701

Alan Ritter
Texas House of Representatives, District 21
P.O. Box 1265
Nederland, TX 77627

Alan Ritter
Texas House of Representatives, District 21
P.O. Box 2910
Austin, TX 78768

John Smith
Louisiana State Senate, District 30
P. O. Box 94183
Baton Rouge, LA 70804

John Smith
Louisiana State Senate, District 30
611-B South 5th Street
Leesville, LA 71446

Honorable David Vitter
United States Senator
516 Hart Senate Office Building
Washington, DC 20510

Honorable David Vitter
United States Senator
3221 Ryan Street, Suite E
Lake Charles, LA 70601

Tommy Williams
Texas State Senator District 4
P.O. Box 8069
The Woodlands, TX 77387

Tommy Williams
Texas State Senator District 4
P.O. Box 12068, Capitol Station
Austin, TX 78711

State Agencies

David Schanbacher
Chief Engineer/Deputy Director, Texas Commission on Environmental Quality
P.O. Box 13087, Mail Code 168
Austin, TX 78711-3087

Glen Shankle
Executive Director, Texas Commission on Environmental Quality
P.O. Box 13087, Mail Code 109
Austin, TX 78711-3087

Mike Rezsutek
J.D. Murphree Wildlife Management Area
10 Parks and Wildlife Drive
Port Arthur, TX 77640

James Sutherlin
J.D. Murphree Wildlife Management Area
10 Parks and Wildlife Drive
Port Arthur, TX 77640

James Brent
Louisiana Department of Environmental Quality
1209 Leesville Avenue
Baton Rouge, LA 70802

Billy Eakin
Louisiana Department of Environmental Quality
1301 Gadwall
Lake Charles, LA 70615

Kevin Natali
Louisiana Department of Environmental Quality, Southwest Regional Office
1301 Gadwall
Lake Charles, LA 70615

Jamie Phillippe
Louisiana Department of Environmental Quality, Water Permits Division
602 N. 5th Street
Baton Rouge, LA 70802

Greg DuCote
Louisiana Department of Natural Resources, Interagency Affairs/Field Services Division
617 North 3rd Street, 10th Floor, Suite 1078
Baton Rouge, LA 70804-4027

Terry Howey
Louisiana Department of Natural Resources, Coastal Management Division
617 North 3rd Street, Suite 1078
Baton Rouge, LA 70804-4027

Brian Marcks
Louisiana Department of Natural Resources, Coastal Management Division, Consistency Section 617 North 3rd Street, Suite 1078
Baton Rouge, LA 70804-4027

Kirk Rhinehart
Louisiana Department of Natural Resources, Office of Coastal Protection and Management
450 Laurel Street, Suite 1501
Baton Rouge, LA 70801

Kyle Balkum
Louisiana Department of Wildlife & Fisheries
2000 Quail Drive
Baton Rouge, LA 70808

Ismail Merhi
Louisiana Dept of Natural Resources, Office of Coastal Protection and Restoration (OCPR)
450 Laurel Street, Suite 1200
Baton Rouge, LA 70804-4027

Rachel Watson
Louisiana Office of Cultural Development, Division of Archeology
P.O. Box 44247
Baton Rouge, LA 70804

Scott Hutcheson
Louisiana State Historic Preservation Officer
State Capital Annex, 1051 North 3rd Street, Suite 405
Baton Rouge, LA 70802

Lonnie Arrington
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

Dr. Brian Babin
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

Jimmie Cooley
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

Scott Hall
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

Steven McReynolds
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

James Webb
Lower Neches Valley Authority
P.O. Box 5117
Beaumont, TX 77708

Koy Howard
Mobile Source Team, Texas Commission on Environmental Quality
P.O. Box 13087, Mail Code 164
Austin, TX 78711-3087

Office of the Governor of Louisiana
P.O. Box 94004
Baton Rouge, LA 70804-9004

Office of the Governor of Texas
P.O. Box 12428
Austin, TX 78711-2428

Donna Phillips
Regional Director, TCEP
5425 Polk Ave, Ste H
Houston, TX 77023-1452

Jerry Clark
Sabine River Authority of Texas
12777 N. Highway 87
Orange, TX 77630

Stanley Mathews
Sabine River Authority of Texas
PO Box 579
Orange, TX 77631

James East
Sabine River Authority
2760 Shadowwood Dr.
Sulphur, LA 70663

Mark Howard
Sabine River Authority
P.O. Box 579
Orange, TX 77631

Jim Brown
Sabine River Authority
P.O. Box 579
Orange, TX 77631

Jack Tatum
Sabine River Authority
P.O. Box 579
Orange, TX 77631

Gerard Sala
Sabine River Authority
P.O. Box 579
Orange, TX 77631

John Payne
Sabine River Authority
P.O. Box 579
Orange, TX 77631

James Pratt
Sabine River Authority, Louisiana
15091 Texas Highway
Many, LA 71449

Jim Washburn
Sabine River Authority-Toledo Bend
Route 1, Box 270
Burkeville, TX 75932

Paul Beard
Sabine-Neches Navigation District
3220 Eugenia Ln.
Groves, TX 77619

Clayton Henderson
Sabine-Neches Navigation District
2348 Highway 69 North
P.O. Box 778
Nederland, TX 77627

Randall Reese
Sabine-Neches Navigation District
P.O. Box 778
Nederland, TX 77627

Mark Fisher
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

Robert Hansen
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

Ron Pedde
Texas Commission on Environmental Quality
12100 Park 35 Circle
Austin, TX 78753

James Moore
Texas Commission on Environmental Quality
ATTN: Michelle Horrocks, Water Quality Section
12100 Park 35 Circle, MC-150
Austin, TX 78753

Raul Cantu
Texas Department of Transportation
125 East 11th Street
Austin, TX 78701

Paul Smith
Texas Department of Transportation
8350 Eastex Freeway
Beaumont, TX 77708-1701

John V. Moser
Texas Department of Transportation, Port Arthur Area Office
8350 Eastex Freeway
Beaumont, TX 77708-1701

William Grimes
Texas General Land Office
P.O. Box 12873
Austin, TX 78711-2873

Tom Calnan
Texas General Land Office, Coastal Management Division
P.O. Box 12873
Austin, TX 78711-2873

Tammy Brooks
Texas General Land Office, Coastal Management Program
Stephen F. Austin Building, 1700 North Congress Avenue
Austin, TX 78701-1495

James E. Bruseth
Texas Historical Commission
P.O. Box 12276
Austin, TX 78711-2276

Mark Wolfe
Texas Historical Commission, Texas State Historic Preservation Officer
1551 Colorado
Austin, TX 78701

Terry Stelly
Texas Parks & Wildlife - Coastal Fisheries
601 Channelview
Port Arthur, TX 77640

Jerry Mambretti
Texas Parks & Wildlife Dept.
601 Channelview
Port Arthur, TX 77640

William Schubert
Texas Parks and Wildlife
1502 FM 517
Dickinson, TX 77539

Dean Bossert
Texas Point National Wildlife Refuge
6144 Terry Lane
Port Arthur, TX 77640

Carla Guthrie
Texas Water Development Board,
Hydrologic and Environmental Monitoring Division
1700 N. Congress Ave.
Austin, TX 78701

Junji Matsumoto
Texas Water Development Board,
Hydrologic and Environmental Monitoring Division
1700 N. Congress Ave.
Austin, TX 78701

Jerry Patterson
Texas General Land Office, Commissioner
Stephen F. Austin Building
1700 North Congress Avenue
Austin, TX 78701-1495

Jimmy Anthony
Louisiana Department of Wildlife & Fisheries
2000 Quail Drive
Baton Rouge, LA 70808

Federal Government

Steve Bainter
U.S. Environmental Protection Agency, Region 6, Ocean Dumping Coordinator
1445 Ross Ave, Suite 1200
Dallas, TX 75202-2733
Jim Herrington

U.S. Environmental Protection Agency
720 East Blackland Road
Temple, TX 76502

Mike Jansky
U.S. Environmental Protection Agency, Region 6,
Office of Planning and Coordination
1445 Ross Ave., Suite 1200
Dallas, TX 75202-2733

Barbara Keeler
Environmental Protection Agency, Region 6
1445 Ross Ave, Suite 1200
Dallas, TX 75202-2733

Robert Lawrence
Environmental Protection Agency, Region 6
1445 Ross Avenue
Dallas, TX 75202-2733

Jeff Riley
Environmental Protection Agency, Region 6
1445 Ross Avenue
Dallas, TX 75202-2733

Donna Anderson
U.S. Fish and Wildlife Service
17629 El Camino Real Road, Suite 211
Houston, TX 77058-3051

David Bernhart
National Marine Fisheries,
ARA, Protected Resources
Division
NMFS-SERO, 263 13th Ave
South
St. Petersburg, FL 33701-5511

Aja Bonner
Centers for Disease Control and
Prevention Current Rotation
4770 Buford Hwy, Bldg 106
Atlanta, GA 30341

Darryl Clark
U.S. Fish & Wildlife Service-
Ecological Services
646 Cajundome Blvd Suite 400
Lafayette, LA 70506

Tim Cooper
Texas Chenier Plain National
Wildlife Refuge Complex
P.O. Box 278
Anahuac, TX 77514

Miles Croom
National Marine Fisheries,
Habitat Conservation Division
263 14th Avenue South
St. Petersburg, FL 33701-5505

Brigette Firmin
U.S. Fish and Wildlife Service
646 Cajundome Blvd Suite 400
Lafayette, LA 70506

Robert Gosnell
Southwest Louisiana National
Wildlife Refuge Complex
Headquarters
1428 Highway 27
Bell City, LA 70630

Richard Hartman
National Marine Fisheries
c/o Louisiana State University
Baton Rouge, LA 70803

David Keys
NOAA Fisheries, NEPA
Coordinator, NMFS-SERO
263 13th Ave South
St. Petersburg, FL 33701-5511

William Klein
USACE, New Orleans District
7400 Leake Ave, Room 137
New Orleans, LA 70118

Ronald Land
Department of Energy Pipeline
850 South Clearview Parkway
New Orleans, LA 70123

Terrie Looney
Sea Grant
1295 Pearl Street
Beaumont, TX 77701

Steve Parris
U.S. Fish and Wildlife Service
17629 El Camino Real Road,
Suite 211
Houston, TX 77058-3051

Capt. J.J. Plunkett
U.S. Coast Guard
2901 Turtle Creek Dr, Suite 200
Port Arthur, TX 77642

Janelle Stokes
USACE, Galveston District
2000 Fort Point Road
Galveston, TX 77550

Rusty Swafford
National Marine Fisheries,
Habitat Conservation Division
4700 Avenue U
Galveston, TX 77551

Don Voros
Southwest Louisiana National
Wildlife Refuge Complex
Headquarters
1428 Highway 27
Bell City, LA 70630

Fort Hood
Headquarters, III Corps Office
of Com. Gen.
Fort Hood, TX 76544

Stephen Spencer
U.S. Department of Interior,
Office of Environmental Policy
and Compliance, Regional
Environmental Officer
1001 Indian School Road NW,
Suite 348
Albuquerque, NM 87104

Tribal

Robert Cast
Caddo Indian Tribe of
Oklahoma
Tribal Historic Preservation
Officer
P.O. Box 487
Binge, OK 73009

Carlos Bullock
Alabama-Coushatta Tribe of
Texas
571 State Park Road 56
Livingston, TX 77351

Bryant Celestine
Alabama-Coushatta Tribe of
Texas
571 State Park Road 56
Livingston, TX 77351

Augustine Asbury
Alabama-Quassarte Tribal Town
P.O. Box 187
Wetumka, OK 74883

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13.0 LIST OF PREPARERS

Name/Title	Experience	FEIS Area of Responsibility
U.S. Army Corps of Engineers, Galveston District		
Janelle Stokes, Regional Environmental Specialist	25 years, Environmental Impact Assessment and Impact Analysis, Cultural Resource Coordination, Archeological Research and Surveys	Project coordination, report preparation, CE/ICA analysis, WVA modeling
Carolyn Murphy, Chief, Environmental Section	27 years, Environmental Impact Assessment and Impact Analysis, Planning and Environmental Resources, Archeological Research and Surveys	Document review
Richard Medina, Chief, Planning and Environmental Branch	35 years, Environmental Impact Assessment and Impact Analysis, Planning and Environmental Resources	Document review
Rob Hauch, Physical Scientist	26 years, Environmental Impact Assessment and Impact Analysis; Dredged Material, Water, and Sediment Quality Analyses	Appendix B preparation assistance, project review
Kristy Morten, HTRW Specialist	28 years, HTRW and Biological Analysis	HTRW, document review
Nicole Minnichbach, Staff Archeologist	7 years, Archeology	Archeology section preparation and review
Nancy Young, Civil Engineer	10 years, Civil Engineer	Engineering design of BU features and mitigation measures
John Damm, Geotechnical Engineer	20 years, Geotechnical Engineer	Engineering design of BU features
Ryan Brown, Geotechnical Engineer	3 years, Geotechnical Engineer	Engineering design of BU features
U.S. Environmental Protection Agency		
Barbara Keeler	30 years of coastal environmental science and NEPA experience for EPA, currently serving as the Region 6 Coastal & Wetlands Planning Coordinator.	Served as the EPA Regional lead for technical and policy EIS review. Participated in this effort as the EPA representative on the Habitat Workgroup and the Sabine-Neches Interagency Coordination Team.
Stephen Bainter	30 years environmental related activities experience, to include experiences in positions as the Municipal Whole Effluent Coordinator, Water Quality Permitting Specialist, and Water Quality Standards Coordinator for EPA Region 6. Currently assigned as EPA Region 6's Ocean Dumping Coordinator.	ODMDS EIS and SMMP technical review.

Name/Title	Experience	FEIS Area of Responsibility
U.S. Environmental Protection Agency, concluded		
Renee Bellew	9 years environmental related activities experience, currently serving as a Water Quality Standards Coordinator for EPA Region 6. Participated in this effort while as the EPA Region 6's Ocean Dumping Coordinator.	ODMDS EIS technical and policy review.
PBS&J		
Martin Arhelger, Vice President, Project Director	30 years, Environmental Assessment and Impact Analysis	Project Manager, water and sediment quality
Angela Bulger	8 years, NEPA Compliance and Coordination	Assistant Project Manager, document coordination
Tony Risko	18 years, Coastal Engineering	Assistant Project Manager
Lisa Vitale, Marine Biologist	15 years, Marine Biology	Assistant Project Manager, Marine Fisheries/EFH, document coordination and production, quality control
Tomas Dixon, Senior Scientist	8 years, Wildlife and Protected Species	Wildlife and threatened & endangered species, BA and CMP preparation
Derek Green, Biologist, Wildlife Specialist	24 years, Environmental Assessment and Analysis	Wildlife and habitat, threatened and endangered species, sea turtle analysis
Erik Huebner, Senior Scientist	10 years, Wildlife and Protected Species	Wildlife and threatened & endangered species
Tommy Ademski, Senior Environmental Planner	10 years, Planning	Noise analysis
Wendy Connally, Ecologist	4 years, Environmental Assessment and Analysis	Cumulative Impacts and QA/QC
Kathy Calnan, Ecology, Botany	16 years, Vegetation Analysis and Impacts	Vegetation Analysis
Dave Buzan, Aquatic Biologist	30 years, Aquatic Biology, Vegetation Analysis and Impacts	Freshwater Fisheries, Vegetation Analysis
Ruben Velasquez, Senior Engineer	30 years, Air Quality	Air Quality, General Conformity
Bob Gearhart, Archeologist, Magnetometer and Side-Scan Sonar Specialist	22 years, Marine Archeology	Marine archeology
Steve McVey, Geologist, HazMat Specialist	12 years, Environmental Geology	HTRW Analysis
Tricia LaRue, Environmental Planner	5 years, Planning and Socioeconomics	Socioeconomics
Michael Hettenhausen, Environmental Planner	2 years, Planning and Document Review	General ecology, document review
Eric Monshaugen, GIS Specialist	4 years, GIS	GIS data/figures
Chris Vidrick, Senior Word Processor	30 years, Word Processing	Word processing, document formatting and review
Bob Bryant, Lead Word Processor	18 years, Word Processing	Word processing, document formatting and review
Linda Nance, Technical Editor	35 years, Editing	Technical document editing

Name/Title	Experience	FEIS Area of Responsibility
Independent Technical Review		
Philip M. Payonk, Chief, Environmental Resources Section, CESAW-TS-PE	27 years Environmental Impact Assessment and Impact Analysis; Dredged Material, Water, and Sediment Quality Analyses; Ocean Disposal Coordinator	Environmental Impact Review; compliance with environmental laws and regulations
Bernard E. Moseby, Economist, CESAM-PD-FE	21 years Economic Analysis, Deep Draft Navigation	Review of Mitigation Measures CE/ICA
Carl E. Dyess, Dredging Project Manager, CESAM-OP	18 years, Dredging Operations Manager	Review of operations and maintenance plans
Wade A. Ross, Supervisory Hydraulic Engineer, CESAM-EN-HH	16 years, Hydraulic Engineer, Deep Draft Navigation	Review of hydrology and hydraulics issues
Dennis E. Mekkers, Hydraulic Engineer, CESAM-EN-HH	12 years, Structural Hydraulic Design, Tidally Influenced Wetlands Modeling and Restoration	Review of HS models
Naomi R. Fraenkel, Civil Engineer, CENAN-PL-F	5 years, Deep Draft Navigation Planning	Review of plan formulation
James A. Wagoner III, Assistance District Counsel, CESAM-OC	18 years, Real Estate Attorney	Real estate issues review
Wallace W. Brassfield, Cost Engineer, CENWW-EC-X	40 years, Construction Cost Estimating	Project costs review

(This page left blank intentionally.)

14.0 LITERATURE CITED

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