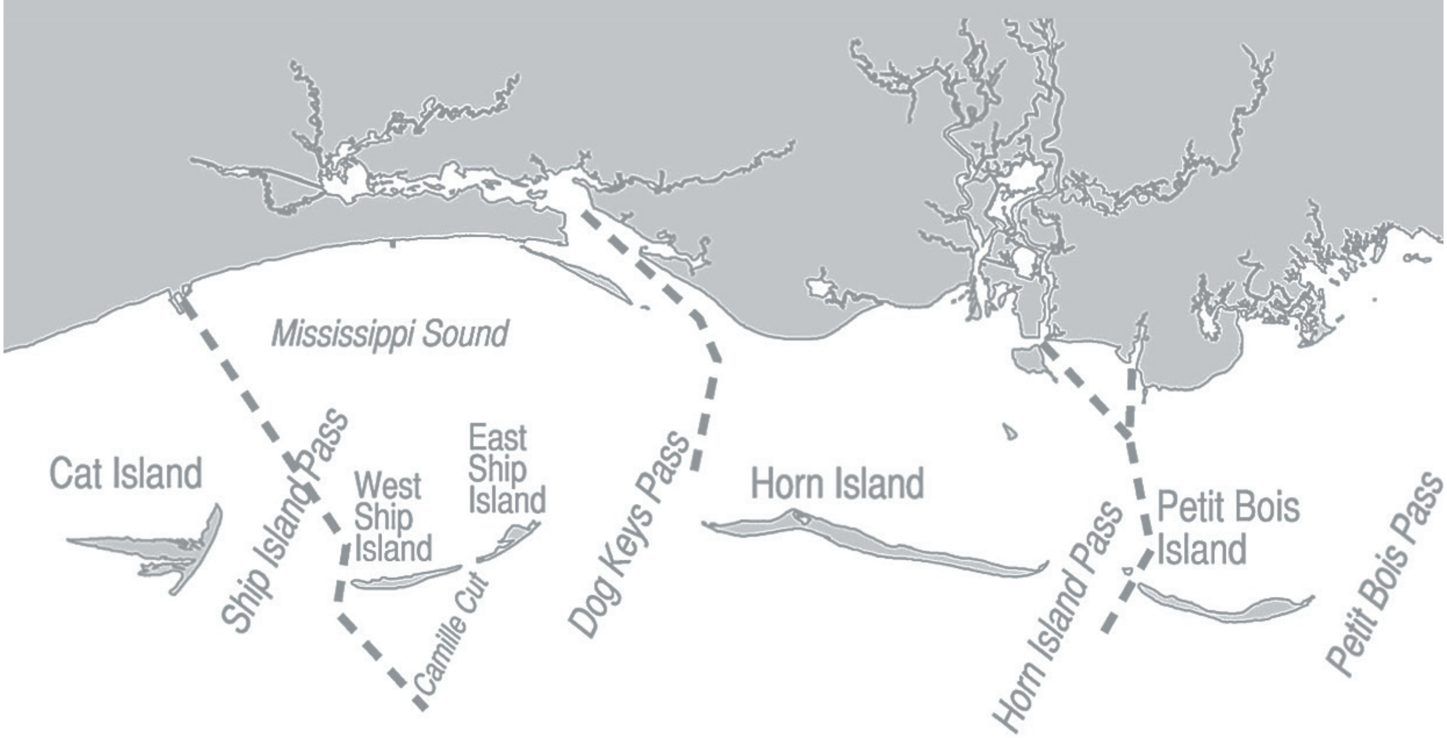
Mississippi Coastal Improvements Program (MsCIP)
Comprehensive Barrier Island Restoration
Hancock, Harrison, and Jackson Counties, Mississippi

Draft Supplemental Environmental Impact Statement

US Army Corps of Engineers®
Mobile District



March 2014

Executive Summary

Project Background

The U.S. Army Corps of Engineers (USACE), Mobile District, proposes to restore a portion of the Mississippi barrier islands in the Gulf of Mexico. This action is related to the consequences of Hurricane Katrina, other hurricanes in the Gulf of Mexico in 2005, and past navigational dredging and disposal activities that have altered sediment availability and transport along the islands. The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement (PEIS) (USACE, 2009a) was developed to support the long-term recovery of Hancock, Harrison, and Jackson Counties from the devastation caused by these hurricanes, as well as to make the coast more resilient against damage from future storms. The MsCIP PEIS was prepared under the authority of the Department of Defense Appropriations Act of 2006 (Public Law 109-148), dated December 30, 2005 and was completed in June 2009. The Report of the Chief of Engineers dated September 15, 2009, and the Record of Decision (ROD) signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010, were submitted to Congress on January 15, 2010. The MsCIP PEIS evaluated an array of measures to address cost-effective solutions for hurricane and storm damage risk reduction, saltwater intrusion, shoreline erosion, preservation of fish and wildlife, and other water-related issues (USACE, 2009a).

The MsCIP PEIS evaluated an array of measures to promote the recovery of coastal Mississippi from damages caused by the hurricanes of 2005 and to increase the resilience of the coast against damage from future storms. The ROD for the MsCIP PEIS recommended a number of key elements for phased implementation over the next 30–40 years. The Comprehensive Plan, as evaluated in the MsCIP PEIS, includes the comprehensive restoration of the Mississippi barrier islands; restoration of over 3,000 acres of wetland and coastal forest habitat; acquisition of approximately 2,000 parcels, with relocation of residents, within the high hazard area; improvement of a levee at the Forest Heights community in Gulfport, Mississippi; a flood-proofing demonstration in Waveland, Mississippi; and the study of 53 other hurricane and storm damage risk reduction and ecosystem restoration options across the coastal area.

This Supplemental Environmental Impact Statement (SEIS) evaluates alternatives designed to accomplish the purpose of and need for the barrier island restoration elements as recommended in the MsCIP Comprehensive Plan and authorized by Congress, as well as the potential environmental impacts and benefits associated with the USACE final design for the plan to implement the authorized construction action in compliance with the National Environmental Policy Act (NEPA) and applicable regulations. The action alternatives considered in this SEIS include potential sand borrow locations and site-specific options for implementing restoration at the sand placement locations authorized for construction. Alternatives considered are tiered from the MsCIP PEIS (40 Code of Federal Regulations [C.F.R.] 1508.28). Thus, those alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis in this document.

Project Area

The project area includes the mainland coast of Mississippi (Hancock, Harrison, and Jackson Counties), Mississippi Sound, the Mississippi-Alabama barrier islands, and the northern Gulf of Mexico to about 8 miles seaward of the barrier islands (Figure ES-1). A chain of sandy barrier islands located from 6–12 miles offshore separates Mississippi Sound from the northern Gulf of Mexico. From east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi. In addition, Sand Island, which has been created through the deposition of dredged material within Disposal Area 10 (DA-10) of the Pascagoula Harbor Federal Navigation project, lies between Petit Bois and Horn Islands.

Dauphin, Petit Bois, Horn, East Ship, and West Ship Islands are located along the modern littoral drift zone that moves sand westward across the islands, resulting in their elongated shapes and westward migration over time (Figure ES-1). The westernmost island, Cat Island, is believed to have originated as part of the Alabama-Mississippi barrier chain (Saucier, 1963; Frazier, 1967; Otvos, 1978, 1981; Kindinger et al., in press). However, wave climate altered by the growth of the St. Bernard Delta into the northern Gulf of Mexico significantly sheltered the island from south and southeast waves that supplied sediment to the island around 4,000 years ago (Frazier, 1967; Penland et al., 1985; Otvos and Giardino, 2004; Twichell et al., 2011; Kindinger et al., in press). Due to the change in oceanic conditions, Cat Island is not part of the modern littoral drift system that supplies sand along the Alabama-Mississippi barrier island chain (Byrnes et al., 2012; Walstra et al., 2012). Thus, Cat Island has experienced more limited migration. Ship Island currently exists as two island segments, East Ship and West Ship, separated by Camille Cut. In 1969, Hurricane Camille substantially breached a part of Ship Island that had been historically vulnerable to breaching, and the breach remains today as a 3.5-mile-wide shallow sandbar between the two small islands.

All of Petit Bois, Horn, East Ship, West Ship Islands, and portions of Cat Island are located within the boundaries of the Gulf Islands National Seashore (GUIS) Mississippi unit under the jurisdiction of the National Park Service (NPS). Petit Bois and Horn Islands also have been designated by the U.S. Congress as the Gulf Islands Wilderness under the Wilderness Act. The remainder of Cat Island is currently under State and private ownership.

Purpose and Need

The MsCIP PEIS evaluated the need for restoring the Mississippi Barrier Islands as part of a comprehensive plan to increase the resiliency of the coast to future storm events. The PEIS recommended a general plan that included the placement of up to 22 million cubic yards to restore islands within the GUIS Mississippi unit and an undetermined quantity of sand in the vicinity of Cat Island. The PEIS also discussed the need to evaluate refinements to the barrier island restoration plan, including locating additional borrow sites and specific design options. This SEIS has been prepared to evaluate and document the impacts of specific alternatives for sand borrow areas, placement options, engineering and design alternatives, and construction methods.

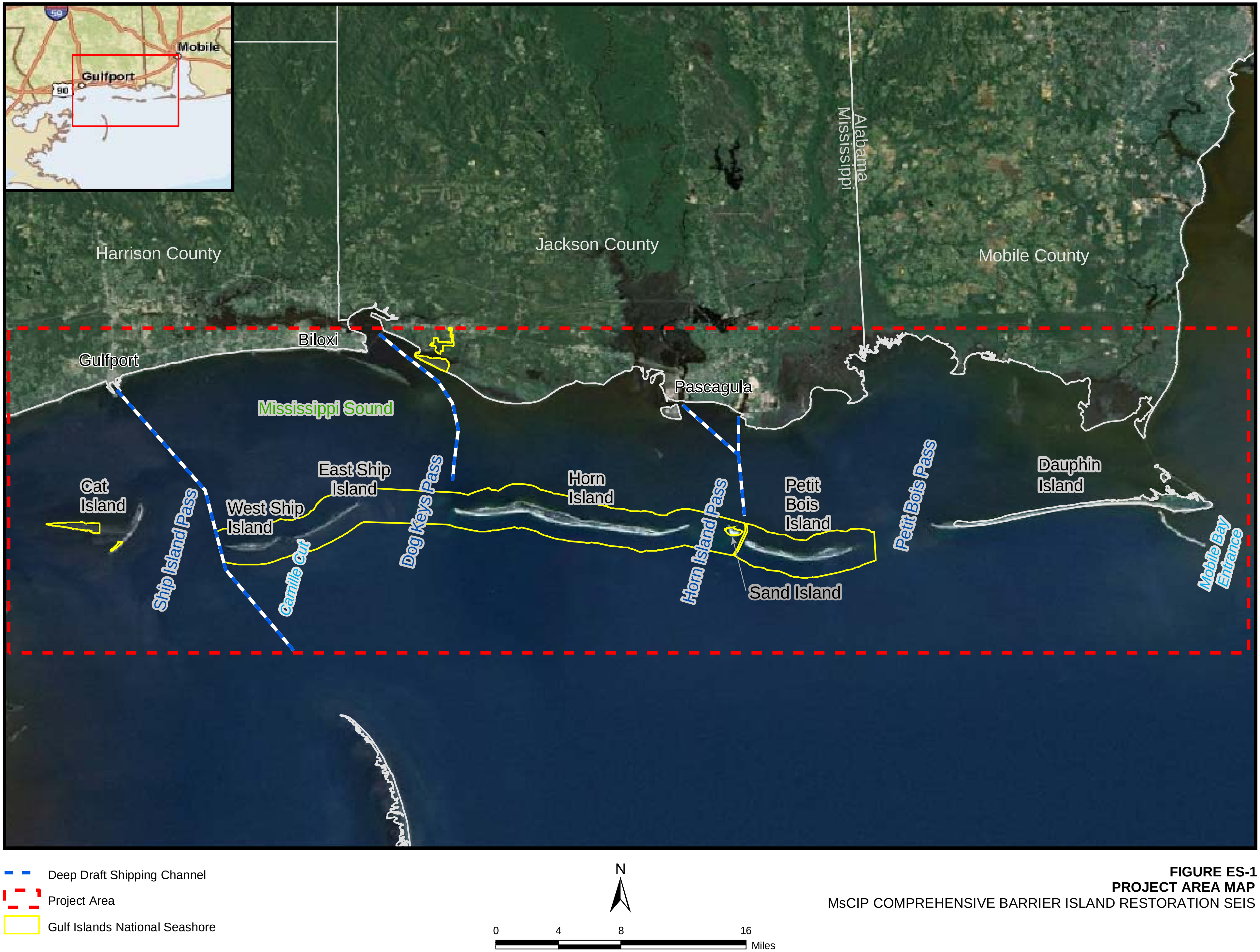


FIGURE ES-1
PROJECT AREA MAP
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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The need for the Proposed Action remains the same as that described in the MsCIP PEIS: implementation of the recommended comprehensive restoration of the barrier islands is required to achieve the goals outlined in the MsCIP PEIS. The restoration of the Mississippi barrier island system is needed to:

- Protect and maintain the estuarine ecosystem of Mississippi Sound and to reduce storm damage incurred along the mainland coast of Mississippi.
- Preserve and protect the Mississippi barrier islands and their natural and cultural resources.
- Reduce erosion and land loss of the barrier islands, especially East and West Ship Islands, and Cat Island to the west.
- Enhance the long-term sand supply to the littoral drift system, which historically has maintained the Mississippi barrier islands through natural processes.

Proposed Action, Programmatic Environmental Impact Statement of June 2009

The USACE's initial plan for restoration under the PEIS serves as the basis for development of alternative actions in this SEIS. The proposed Comprehensive Barrier Island Restoration element as described in the MsCIP PEIS includes restoration of the Mississippi barrier islands through the placement of up to 22 million cubic yards (mcy) of sand within the GUIS Mississippi unit and an undetermined quantity of sand in the vicinity of Cat Island. In the MsCIP PEIS, the overall recommendation to return sand to the system included:

- Filling Camille Cut, the 3.5-mile breach in Ship Island
- Adding sand to the littoral system on the east end of Petit Bois Island
- Adding sand to the littoral system on the east end of East Ship Island
- Adding sand to the littoral system on the east end of Cat Island

Tentatively Selected Plan, Supplemental Environmental Impact Statement of 2013

The original MsCIP PEIS evaluated a general restoration plan that included the placement of material between East and West Ship Islands to fill Camille Cut and placement of sand within the littoral zones of Cat, East Ship, and Petit Bois Islands, with preliminary estimates of the volume of fill material required. The PEIS also recommended that additional analyses be completed prior to implementation of restoration to identify the most effective plan(s) for restoring the barrier island system. The alternatives evaluated for this SEIS are based on this additional information including geophysical and geotechnical evaluations, revised sediment budget analysis, and a suite of hydrodynamic, sediment transport, and morphological modeling efforts. These updated alternatives are based on differing design configurations using varying quantities and multiple sources of sand with different median grain sizes and include:

- Restoration of Ship Island, including Sand Placement in Camille Cut and Replenishment of the Southern Shoreline of East Ship Island

- Beach-front Placement of Sand Along Cat Island
- Management of Future Dredged Material from Pascagoula Ship Channel

From the updated evaluations, a Tentatively Selected Plan (TSP) has been developed which fulfills the goals identified in the MsCIP PEIS for restoration of the Mississippi barrier islands to sustain Mississippi Sound's productive ecological system while also providing the first line of defense, resulting in a more resilient coast.

The following paragraphs provide details on each of the TSP components.

Ship Island Restoration

The restoration of Ship Island includes the closure of Camille Cut, restoration of the shoreline of the current East Ship Island, and use of sand from five borrow sites (referred to as Borrow Site Option 4, based on multiple alternatives being initially considered). This restoration would be accomplished in 5 phases over an approximately 2.5-year period and is summarized below, by component. The combined Camille Cut and East Ship Island equilibrated fill would encompass approximately 1,500 acres, of which 800 acres would be above mean high water level (MHWL). The placement on Ship Island would be a one-time event.

Direct Sand Placement in Camille Cut

To restore East Ship Island and West Ship Island to a single elongated barrier island, the approximately 3.5-mile-long Camille Cut would be filled with approximately 13.5 mcy of sand. The newly formed island segment would be constructed as a low-level dune system connecting existing West Ship and East Ship Islands. Under the proposed design template, the constructed Camille Cut closure would be approximately 1,100 feet wide. The fill would tie into the existing island shoreline just below the frontal dune line at an elevation of approximately +7 feet North American Vertical Datum of 1988 (NAVD88) with a 1V:12H (vertical:horizontal) slope to the MHWL and an approximate 1V:20H slope below the MHWL. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the proposed East Ship Island placement.

As sand placement in Camille Cut progresses, the newly created island segment would be stabilized with sand fencing and planted with native dune vegetation, including sea oats and/or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in groupings along all shorelines within the newly created beach.

Replenishment of East Ship Island

The restoration of East Ship Island would consist of the placement of approximately 5.5 mcy of sand along the southern shoreline. In addition to restoring the southern shoreline, placement of sand in this area would add material to the newly restored Camille Cut fill and therefore support the overall replenishment of the system as identified in the sediment budget analysis and sediment transport modeling. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1:20 slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom).

Borrow Site Option 4

A total of 19.0 mcy of sand, which includes volumes necessary to account for 5 to 10 percent placement losses, would be required to be dredged from five borrow areas to provide the needed quantity for the Camille Cut closure and restoration of East Ship Island. These borrow areas include: Ship Island (1.2 mcy), Petit Bois Pass–Alabama (PBS-AL) (8.5 mcy), Petit Bois Pass-Mississippi (PBP-MS) (2.0 mcy), Petit Bois Pass–Outer Continental Shelf (PBP-OCS) (4.1 mcy), and Horn Island Pass (3.2 mcy). Sand from borrow sites would be dredged with a hopper dredge or cutterhead dredge, loaded into scows, hauled to the placement vicinity, and then pumped directly onto the site. Placement of the material would be concurrent with the fill of Camille Cut.

Two proposed borrow sites are located outside waters of the State of Mississippi, including the Petit Bois-AL and Petit Bois Pass-OCS. Use of material from these sites requires additional coordination as described below:

The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. Removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52), and either a direct sale or royalty payment may be charged for removal.

The Bureau of Ocean Energy Management (BOEM) is the agency of the Department of the Interior tasked with managing the extraction of offshore minerals from America's OCS. While the largest component of this management is related to exploration for and development of oil and gas resources, the Bureau is also responsible for what are loosely referred to as "non-energy minerals" (primarily sand and gravel) obtained from the ocean floor. BOEM jurisdiction for leasing and regulating the recovery of minerals extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS. 43 U.S.C. 1337(k)(2) allows the BOEM to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded in whole or part by or authorized by the Federal Government, without payment of fees. Any sand removed from the OCS requires review and an agreement from the BOEM.

Cat Island Restoration

Dune and beach restoration on Cat Island, including revegetation, would be implemented through the direct placement of approximately 2 mcy of sand on the eastern beach fronting Cat Island. The recommended design is largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. The construction template would include an average dune crest width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed crest width of approximately 250 feet at an elevation of approximately +5 feet NAVD88 with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would restore the island habitats, thereby enhancing the island’s ability to absorb energy from westward-propagating waves. The construction profile would be expected to adjust rapidly through the erosion of the upper profile and mimic the natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages 175–200 feet. The total equilibrated fill area encompasses approximately 305 acres.

Sand used in the restoration of Cat Island would come from an approximately 282-acre sand deposit in an area about 2 miles long and 0.2-mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-14). The proposed borrow site is located east of the placement area and outside of the GUIS boundaries. The borrow site would be dredged to a depth of approximately 3-5 feet.

The proximity of the borrow area to the eastern shoreline of Cat Island in relatively shallow water would allow for the rapid placement of sand on the beach, likely using a hydraulic pipeline dredge. The material would be pumped directly onto the beach and reworked (shaped) by land-based equipment. Following placement, the area would be revegetated with native grasses. Restoration construction would occur over approximately 6 months. The placement of sand would be a one-time event.

Management of Littoral Placement of Future Dredged Material from Pascagoula Federal Navigation Channel

The TSP includes revisions to the dredged material placement practices within the littoral zone of the Horn Island Pass portion of the Pascagoula Federal Navigation Channel. The intent of the revisions is to ensure that placement of future dredged material within the littoral zone best replicates natural sediment pathways in the system and minimizes potential adverse impacts to the surrounding area while not increasing costs to operation of the Pascagoula Federal Navigation Channel. The TSP includes placement of the suitable sandy material dredged from the Horn Island Pass portion of the Pascagoula Federal Navigation Channel along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential. These shoals are located in the south and west portions of the existing specified Disposal Area 10 (DA-10) and the northern portion of the existing specified Littoral Zone disposal site. The total area for potential direct placement would encompass approximately 1,600 acres, including a portion of the existing DA-10 and the existing Littoral Zone placement site, with existing depths generally between 5 and 30 feet. The optimum dredge placement location for hydraulic pipeline dredges is in the shallow waters just southwest of Sand Island. This area is preferred from the standpoint of both sediment transport potential and operations to minimize unnecessary pumping distances. The deeper waters are required for hopper dredges that cannot operate on the shallow shoals.

No-Action Alternative

The No-Action Alternative represents the future without-project conditions that would occur in the project area without comprehensive restoration of the Mississippi barrier islands. The MsCIP PEIS (USACE, 2009a), from which this SEIS is tiered, describes future without-project conditions and evaluates the environmental effects of the No-Action Alternative. The No-Action Alternative serves in this SEIS as the baseline against which potential environmental impacts and benefits associated with site-specific implementation aspects of the barrier island restoration are compared.

The No-Action Alternative would involve continuing erosion of the barrier islands, increasing salinity of Mississippi Sound, and continuing degradation and loss of estuarine habitats and productive fisheries (USACE, 2009a). The No-Action Alternative assumes that net land loss and morphological changes would continue along the barrier islands into the future, primarily as a result of storms. Historical analysis of barrier island change provided by Morton (2008) and recent analysis by Byrnes et al. (2012) indicate that East Ship Island would continue to narrow and lose land area under this alternative. Sand available for transport from East Ship Island would be depleted in a matter of decades, as storm and normal transport processes reduce the island to a shoal. Dog Keys Pass would become wider as East Ship Island evolves to a shoal, and natural sediment bypassing to West Ship Island would be greatly diminished. In addition, Cat Island would continue to lose land area from persistent erosion due to increased exposure to southeast waves from the Gulf.

Under the No-Action Alternative, loss of coastal ecotone habitat would continue. Barrier islands and beaches along eroding margins of the islands would transition to open-water habitat. These changes would alter and reduce the integrity of existing beach and nearshore habitats for use by communities of terrestrial and benthic invertebrates, fish, wetland plants, submerged aquatic vegetation (SAV), marine mammals, and marine and coastal birds (USACE, 2009a). Beach and littoral habitats for threatened and endangered species such as Gulf sturgeon, sea turtles, and piping plover would also diminish. Loss of the barrier structure provided by the presence of the barrier islands would allow for the free exchange of higher-salinity Gulf waters into Mississippi Sound in an area which has historically been impacted by a reduction in the quantity and timing of freshwater flows from river systems entering the Sound. This alteration of water quality in Mississippi Sound as a result of increasing salinity would threaten commercial and recreational fishing as well as essential fish and shellfish habitats for estuarine species. In addition, unprotected cultural resource sites along eroding shorelines of the barrier islands could be lost.

Under the No-Action Alternative, the loss of the barrier islands would threaten the estuarine ecosystem of Mississippi Sound and expose the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms. In addition, the structural integrity and efficacy of the barrier islands as a first line of defense of mainland habitats would continue to diminish, reducing the resilience of the coast against damage from future storms.

As documented in the MsCIP PEIS (USACE, 2009a), the No-Action Alternative would fail to address the need for comprehensive improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. Although it was determined not to meet the purpose and need for implementing barrier island restoration, the No-Action Alternative is considered herein to meet the requirements of NEPA and to serve as the baseline for evaluating the effects of the TSP.

Impacts Summary

Implementation of the TSP to restore the Mississippi barrier island system would result in both negative and beneficial impacts to placement and borrow areas and to the users of these areas. Negative impacts include the permanent loss of open water habitat at Camille Cut, construction-related short- to long-term disruptions to birds and other wildlife on Ship and Cat Islands, and construction-related disruptions to public use of borrow and placement areas.

However, the overall significant long-term system-wide benefits to the ecosystem and associated losses outweigh the negative impacts. Restoration would provide for additional nesting habitat for threatened and endangered sea turtles and over-wintering critical habitat for the piping plover as well as habitat for neotropical migrants and waterfowl. Closure of Camille Cut would help to maintain the salinity regime in the Sound and the habitat conditions for oysters and numerous estuarine dependent fish and crustacean species that are essential for commercial and recreational fishing. In addition, the barrier island restoration would help to continue to protect the significant historical and cultural sites within the GUIS. The anticipated reduction in storm surges would also help to protect unique coastal mainland habitats, wetlands, and special aquatic sites (including the Grand Bay National Estuarine Research Reserve [NERR]).

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Acronyms and Abbreviations

ACHP	Advisory Council on Historic Preservation
APE	Area of Potential Effects
BA	biological assessment
BOEM	Bureau of Ocean Energy Management
CAA	Clean Air Act
CEQ	Council on Environmental Quality
C.F.R.	Code of Federal Regulations
CO	carbon monoxide
CSLC	California State Lands Commission
CWA	Clean Water Act
cy/yr	cubic yards per year
CZMA	Coastal Zone Management Act
D50	median particle diameter
DA	disposal area
DAMOS	Disposal Area Monitoring System
dB	decibel
dBA	A-weighted decibel scale
DO	dissolved oxygen
EA	environmental assessment
EFH	essential fish habitat
EIFS	economic impact forecasting system
EIS	environmental impact statement
EJ	Environmental Justice
ERDC	Engineer Research and Development Center
ESA	Endangered Species Act
FEMA	Federal Emergency Management Agency
FNU	formazin nephelometric units
Fed. Reg.	*Federal Register*
FWCAR	Fish and Wildlife Coordination Act Report
GIWW	Gulf Intracoastal Waterway
GMFMC	Gulf of Mexico Fishery Management Council
GRBO	Gulf of Mexico Regional Biological Opinion
GSCH	Gulf sturgeon critical habitat
GSMFC	Gulf States Marine Fisheries Commission
GUIS	Gulf Islands National Seashore
HAB	harmful algal bloom
Hz	hertz

IMMS	Institute for Marine Mammal Studies
IPCC	Intergovernmental Panel on Climate Change
KCS	Kansas City Southern
km	kilometer
lb/Mgal	pounds per million gallons
µm	microns
µPa/m	microPascal per meter
MAWSS	Mobile Area Water and Sewer System
MBTA	Migratory Bird Treaty Act
MCA	Mississippi Coastal Assessment Program
MCP	Mississippi Coastal Program
mcy	million cubic yards
MDEQ	Mississippi Department of Environmental Quality
MDES	Mississippi Department of Employment Security
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife, Fisheries, and Parks
mgd	million gallons per day
mg/L	milligrams per liter
mg/m^2	milligrams per square meter
MHWL	mean high water level
MHHW	mean higher high water
MHT	mean high tide
MLT	mean low tide
MLLW	mean lower low water
mm	millimeters
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Service
MPA	Marine Protected Area
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSAAS	"Benthic Macroinfauna Community Characterizations in the Mississippi Sound and Adjacent Areas" study
MsCIP	Mississippi Coastal Improvements Program
MSEMA	Mississippi Emergency Management Agency
MSPA	Mississippi State Port Authority at Gulfport
MSU	Mississippi State University
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves Protection and Repatriation Act
NAVD88	North American Vertical Datum of 1988
NCA	National Coastal Assessment
NCDDC	National Coastal Data Development Center
NEP	National Estuary Program
NEPA	National Environmental Policy Act
NERR	National Estuarine Research Reserve
NHPA	National Historic Preservation Act

NOAA	National Oceanic and Atmospheric Administration
NOAA Fisheries	formerly National Marine Fisheries Service (NMFS)
NOI	Notice of Intent
NOx	nitrogen oxides
NPS	National Park Service
NRC	National Research Council
NRHP	National Register of Historic Places
NTUs	nephelometric turbidity units
NWI	National Wetlands Inventory
OCS	Outer Continental Shelf
OSAT3	Operational Science Agency Team
PBP-AL	Petit Bois Pass-Alabama
PBP-MS	Petit Bois Pass-Mississippi
PBP-OCS	Petit Bois Pass-Outer Continental Shelf
PEIS	Programmatic Environmental Impact Statement
P.L.	Public Law
PM	particulate matter
ppm	parts per million
ppt	parts per thousand
re	relative to
ROD	Record of Decision
ROI	Region of Influence
SAV	submerged aquatic vegetation
SEIS	Supplemental Environmental Impact Statement
SHPO	State Historic Preservation Office
SIP	State Implementation Plan
SOx	sulfur oxides
SRCC	Southeast Regional Climate Center
THC	total hydrocarbons
TOC	total organic carbon
TOG	total organic gases
TPH	total petroleum hydrocarbons
TSP	Tentatively Selected Plan
USACE	U.S. Army Corps of Engineers
U.S.C.	U.S. Code
USCG	U.S. Coast Guard
USDOC	U.S. Department of Commerce
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
WSOF	Wetland Statement of Findings

1. Introduction

In response to the devastation caused by Hurricane Katrina, the Secretary of the Army was directed to prepare a comprehensive plan for improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes (Department of Defense Appropriations Act of 2006 [Public Law (P.L.) 109-148]). The Mississippi Coastal Improvements Program (MsCIP) Comprehensive Plan and Integrated Programmatic Environmental Impact Statement, hereafter referred to as the MsCIP PEIS (U.S. Army Corps of Engineers [USACE], 2009a) was completed in June 2009 to support the long-term recovery of Hancock, Harrison, and Jackson Counties in Mississippi with the goal of enhancing the resilience of the coastal area and its communities against future events, including storms. The Report of the Chief of Engineers dated September 15, 2009, and the Record of Decision (ROD) signed by the Assistant Secretary of the Army for Civil Works dated January 14, 2010, were submitted to Congress on January 15, 2010 (USACE, 2009b; USACE, 2010a).

The MsCIP PEIS evaluated an array of measures to promote the recovery of coastal Mississippi from the hurricanes of 2005 and to increase the resilience of the coast against damage from future storms. The ROD for the MsCIP PEIS recommended several key elements for phased implementation over the next 30–40 years. The Comprehensive Plan, as evaluated in the MsCIP PEIS, includes the comprehensive restoration of the Mississippi barrier islands; restoration of more than 3,000 acres of wetland and coastal forest habitat; acquisition of approximately 2,000 parcels, with relocation of residents, within the high hazard area; improvement of a levee at the Forest Heights community in Gulfport, Mississippi; a flood-proofing demonstration in Waveland, Mississippi; and the study of 53 other hurricane and storm damage risk reduction and ecosystem restoration options across the coastal area.

The Supplemental Appropriations Act, 2009 (P.L. 111-32), provided funds and direction to the Secretary of the Army to restore historic levels of storm damage risk reduction to the Mississippi Gulf Coast through barrier island and ecosystem restoration. The MsCIP PEIS addressed the general plan for comprehensive barrier island restoration, but the final design was not complete at the time because specific sand borrow sources and the placement templates had not been completed. To ensure full compliance with the National Environmental Policy Act (NEPA), the USACE's Mobile District prepared this Supplemental Environmental Impact Statement (SEIS) in cooperation with other federal, state, and local agencies. This SEIS is tiered from the MsCIP PEIS (USACE, 2009a), which evaluated a full range of barrier island ecosystem restoration alternatives, from very limited restoration of East Ship Island and West Ship Island to massive restoration of the islands' historical dimensions (USACE, 2009a). The ROD for the MsCIP PEIS recommended a comprehensive restoration plan that combined two of these alternatives (USACE, 2010a). Therefore, new alternatives to barrier island restoration and protection of Mississippi Sound are not considered in this SEIS. Rather, the alternatives considered herein are focused specifically on site-specific borrow areas, placement area design, and construction methods for implementing the barrier island restoration plan.

The USACE is serving as the lead federal agency during preparation of the SEIS. The following agencies have participated in the development of the Tentatively Selected Plan (TSP) and have agreed to participate as cooperating agencies:

- U.S. Environmental Protection Agency (USEPA)
- U.S. Department of the Interior—National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS), Bureau of Ocean Energy Management (BOEM), and U.S. Geological Survey (USGS)
- U.S. Department of Commerce (USDOC)—National Oceanic and Atmospheric Administration (NOAA) and National Marine Fisheries Service (NOAA Fisheries)
- Mississippi Department of Marine Resources (MDMR)
- Mississippi Department of Environmental Quality (MDEQ)
- Mississippi Department of Archives and History
- Mississippi Museum of Natural Science
- Alabama Department of Conservation and Natural Resources

The USACE conducted extensive public involvement during development of the MsCIP PEIS. Those efforts, along with public involvement associated with development of this SEIS, are summarized in Section 7.

1.1 Mississippi Coastal Improvements Program Comprehensive Plan

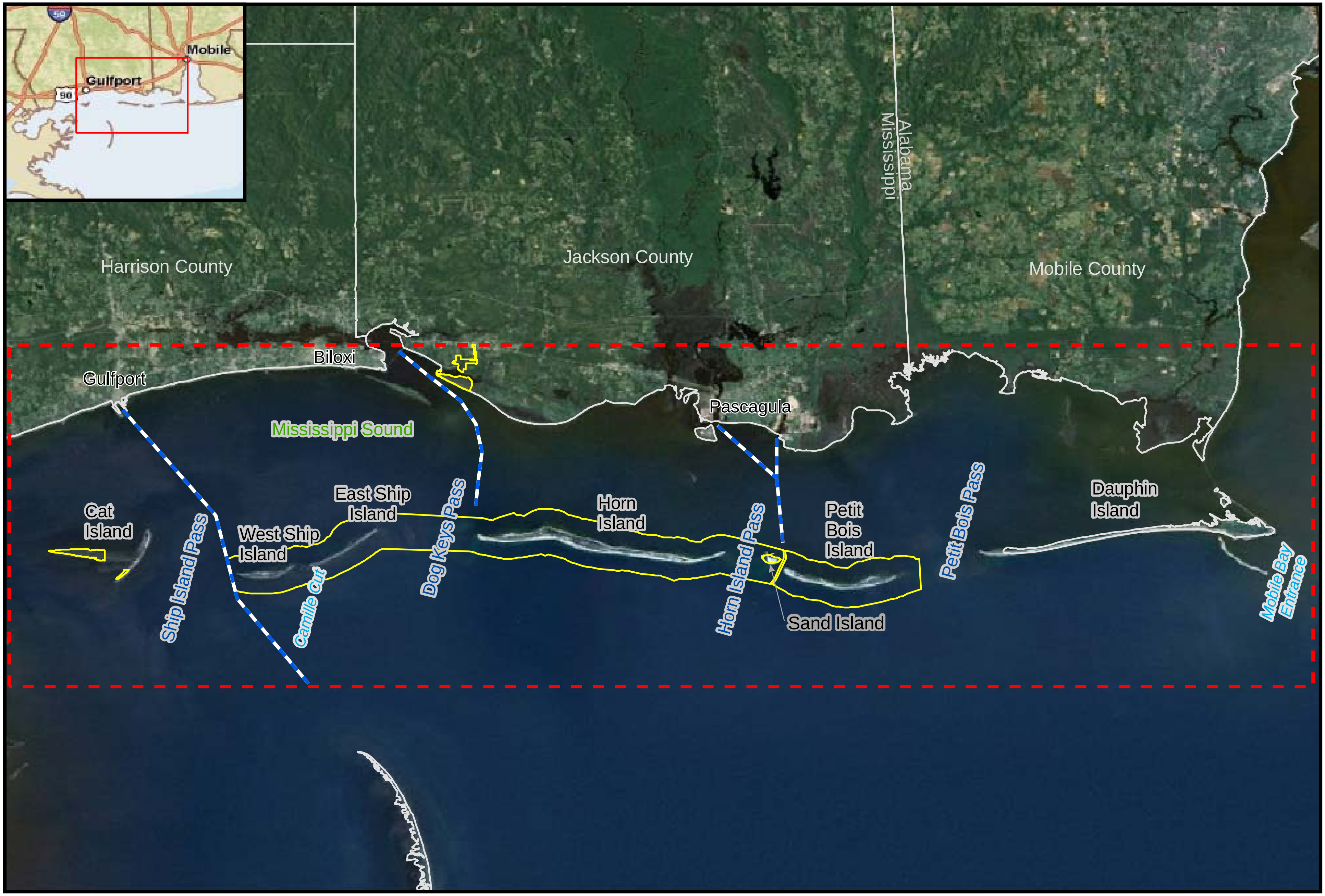
The Mobile District, in partnership with the State of Mississippi, developed the MsCIP PEIS to address cost-effective solutions for hurricane and storm damage risk reduction, saltwater intrusion, shoreline erosion, and preservation of fish and wildlife (USACE, 2009a). The MsCIP PEIS uses a systemwide approach linking structural and nonstructural hurricane and storm damage risk reduction elements with ecosystem restoration elements, all with the goal of providing a coastal community that is more resilient against hurricanes and storms. The plan used a "Lines of Defense" concept incorporating a group of alternative measures that function together as a comprehensive approach to addressing problems and opportunities. The grouping of alternative measures integrates structural, nonstructural, and ecosystem restoration measures. This concept progresses geographically from the offshore barrier islands to what could be considered the inland surge extent of the worst possible theoretical storm (USACE, 2009a). The MsCIP PEIS identified, screened, evaluated, prioritized, and optimized a broad array of alternatives. Comprehensive barrier island restoration, as a first line of defense against hurricane and storm damage, was one of several key elements recommended in the MsCIP PEIS (USACE, 2009a). Restoration of the Mississippi barrier island system would provide significant systemwide benefits to the habitats of the Gulf Islands National Seashore (GUIS) and other ecosystems, as well as economic benefits associated with damage and fishery losses avoided and other regional benefits (USACE, 2009a). Most notably, comprehensive barrier island restoration would help maintain the fragile Mississippi Sound ecosystem with its economic, recreational, environmental, and aesthetic benefits, and provide additional habitat for federally protected species of sea turtles and birds. The analyses provided in the MsCIP PEIS indicate that the comprehensive barrier island restoration would result in the restoration of 1,150 acres of critical coastal zone habitats and improvement to the water quality of Mississippi Sound by maintaining the salinity regime in the Sound. In addition, some level of protection would be afforded to cultural sites on East Ship Island and West Ship Island, which are listed on the National Register of Historic Places (NRHP). Other benefits would include annual hurricane and storm damage risk reduction of $20 million to mainland Mississippi, $470,000 in average annual recreation benefits, and $43 million in average annual fishery losses avoided.

Given the chronic erosion processes along the barrier islands and their threat to natural and cultural resources, NPS—in collaboration with USACE, USGS, NOAA Fisheries, USEPA, NOAA, USFWS, MDEQ, and MDMR—concluded in the MsCIP PEIS that specific emergency actions and long-term habitat restoration are crucial for preserving and protecting the Mississippi barrier islands and their natural and cultural resources. As such, this SEIS for Mississippi barrier island restoration reflects extensive interagency consultation and collaboration.

1.2 Barrier Island Restoration Project Area

The project area for the comprehensive restoration of the Mississippi barrier islands extends from the mainland coast of Mississippi (Hancock, Harrison, and Jackson Counties) to the south across Mississippi Sound and the Mississippi-Alabama barrier islands into the northern Gulf of Mexico to a distance about 8 miles seaward of the barrier islands (Figure 1-1). Mississippi Sound is a shallow, estuarine body of water ranging 6–12 miles wide, extending approximately 90 miles along the coast from the juncture with Mobile Bay, Alabama, west to the mouth of Lake Borgne, Louisiana. Several navigation channels traverse Mississippi Sound. The Gulf Intracoastal Waterway (GIWW) provides a shallow-draft channel for navigation that parallels the mainland coast through the entire length of Mississippi Sound. Three Federal navigation channels—Gulfport, Biloxi, and Pascagoula—extend into Mississippi Sound from the Mississippi mainland, and one channel, Bayou La Batre, extends into the Sound from the Alabama mainland. The USACE dredges the four channels regularly.

A chain of six sandy barrier islands 6–12 miles offshore of Mississippi and Alabama separate Mississippi Sound from the northern Gulf of Mexico. From east to west, the islands are Dauphin Island in Alabama and Petit Bois, Horn, East Ship, West Ship, and Cat Islands in Mississippi (Figure 1-1). The barrier island chain includes dynamic and diverse habitats that are part of a complex integrated system of beaches, dunes, marshes, maritime forest, bays, tidal flats, and inlets. The five eastern barrier islands (Dauphin, Petit Bois, Horn, and East Ship Island, and West Ship Island) are within a littoral drift zone that moves sand westward along the islands, resulting in their elongated shapes and westward migration over time. The westernmost island, Cat Island, is believed to have originated as part of the Alabama-Mississippi chain (Saucier, 1963; Frazier, 1967; Otvos, 1978; Kindinger et al., in press). However, wave climate altered by the growth of the St. Bernard Delta into the northern Gulf of Mexico significantly sheltered the island from south and southeast waves that supplied sediment to the island around 4,000 years ago (Frazier, 1967; Penland et al., 1985; Otvos and Giardino, 2004; Twichell et al., 2011; and Kindinger et al., in press). Due to the change in oceanic conditions, Cat Island is not part of the modern littoral drift system that supplies sand along the Alabama-Mississippi barrier island chain (Byrnes et al., 2012; Walstra et al., 2012). Thus, Cat Island has experienced more limited migration.



Deep Draft Shipping Channel

Project Area

Gulf Islands National Seashore

FIGURE 1-1
PROJECT AREA MAP
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Ship Island exists as two island segments—East Ship Island and West Ship Island—separated by Camille Cut (Figure 1-1). In 1969, Hurricane Camille breached a portion of Ship Island that historically had been vulnerable to breaching. Hurricane Katrina substantially changed the area of Camille Cut, and caused significant erosion of East Ship Island. Although these breaches have partially healed naturally over time in the past, studies by Morton (2008) and Byrnes et al. (2012) indicate that the current breach would not heal as in the past. The breach remains today as a 3.5-mile-wide shallow submerged sandbar between the two small islands.

Two maintained navigation channels extend through passes in the Mississippi barrier islands. The Pascagoula Federal Navigation project extends through Horn Island Pass near the west end of Petit Bois Island. The Gulfport Federal Navigation project Bar Channel segment extends through Ship Island Pass near the west end of West Ship Island.

All of Petit Bois, Horn, East Ship, and West Ship Islands, and parts of Cat Island, are within the boundaries of the GUIS Mississippi unit under the jurisdiction of the NPS (Figure 1-1). The U.S. Congress has designated Petit Bois and Horn Islands as the Gulf Islands Wilderness under the Wilderness Act. The designation affords additional significance and protection to the islands.

1.3 Gulf Islands National Seashore

GUIS is a unit of NPS that includes natural, cultural, and recreational resources along the northern Gulf of Mexico coasts of Mississippi and Florida. These resources include several coastal defense forts spanning more than 2 centuries of military activity, with archaeological features, coastal barrier islands, salt marshes, bayous and submerged seagrass beds, complex terrestrial communities, emerald green water, and white sand beaches. The barrier islands within GUIS are nationally significant for several reasons. Specifically, the islands:

- Contain an extensive collection of publicly accessible seacoast defense structures in the U.S., representing a continuum of development from early French and Spanish exploration and colonization through World War II.
- Provide for public recreational opportunities on natural and scenic island, beach, and water areas that possess the rare combination of remaining undeveloped land in a wilderness state, yet being close to major population centers.
- Provide habitat for several endangered species in diverse ecosystems, stopover habitat for migratory birds, and critical nursery habitat for marine flora and fauna; serve as an enclave for the complex terrestrial and aquatic plant and animal communities that characterize the northern Gulf Coast; and illustrate the natural processes that shape these unique areas.
- Contain land and marine archaeological resources that represent a continuum of human occupation in a coastal environment and are important in enhancing the knowledge of the past, including interactions between the earliest settlers and original inhabitants of this area of the Gulf Coast.
- Provide a benchmark to compare conditions in developed areas of the Gulf Coast to natural areas within the park.

The Mississippi barrier islands within GUIS are Petit Bois, Horn, East Ship Island, West Ship Island, and parts of Cat Island (Figure 1-1). In most cases, their boundaries extend 1 mile from the shore. The exception is Cat Island, where the boundary between GUIS and state waters is the mean high tide line. Also within the boundary is the manmade (subaerial, or above the water surface) part of Disposal Area 10 (DA-10) of the Pascagoula Harbor project, locally known as Sand Island, located west of the Pascagoula Ship Channel and north and east of the eastern end of Horn Island. In addition, NPS administers the 401-acre Davis Bayou area on the mainland near Ocean Springs, Mississippi.

The GUIS has the following purposes:

- Preserving, protecting, and interpreting the Gulf Coast barrier island and bayou ecosystems and the system of historic coastal defense fortifications
- Providing for public use and enjoyment of these resources to the extent possible

1.4 Additional Engineering and Design Studies

Preconstruction engineering and design studies relative to comprehensive barrier island restoration began in July 2009. The purpose of the studies was to support the final engineering and design for implementation of the project. Detailed studies provided data on the site-specific aspects of proposed sand borrow locations and placement areas, and procedures for construction of barrier island restoration elements. The following additional studies were conducted on hydrodynamics, sediment transport, cultural resources, and biological conditions within the project area to evaluate impacts of specific alternatives:

- Geophysical surveys to locate and quantify potential sand borrow locations that could be useful in replenishing the sediment budget for the barrier islands (Appendix A).
- Sediment transport assessment to update the sediment budget for the barrier islands (Appendix B).
- Site-specific modeling of sand transport, wave propagation, and geomorphic change resulting from proposed sand placement (Appendix C).
- Hydrodynamic and water quality numeric modeling to refine the restoration alternatives based on analysis of waves, currents, circulation, water quality, and sediment transport (Appendix D).
- Analysis of littoral and shoreline impacts associated with borrow activities at the Cat Island borrow area (Appendix E).
- Analysis of circulation and sediment transport potential associated with borrow activities at DA-10 (Appendix F).
- Applied coastal pipeline impact assessment, to simulate the potential impacts of borrow site excavation on sediment transport along the Gulfstream Pipeline (Appendix G).
- Biological survey to characterize seagrass communities occurring in or adjacent to potential borrow areas and littoral zone placement areas (Appendix H).

- Biological surveys to characterize benthic macroinvertebrate communities occurring in potential borrow areas and littoral zone placement areas (Appendix I).
- Weekly bird surveys in five locations (eastern and western East Ship Island, eastern and western West Ship Island, and Sand Island within DA-10) to characterize bird communities (Appendix J).
- Summary of Gulf sturgeon (*Acipenser oxyrinchus desotoi*) telemetry monitoring at Ship Island (Appendix K).
- Engineering analysis of Camille Cut closure options (Appendix L).
- NPS Wetland Statement of Findings—analysis of potential wetland impacts within the GUIS based on NPS Director's Order 77-1 (Appendix M).
- Biological assessment—analysis of potential impacts on threatened and endangered species (Appendix N).
- Maps of essential fish habitat by species within the project area (Appendix O).
- Analysis of alternatives related to wetland impacts under Section 404(b)(1) of the CWA (Appendix P).
- Fish and Wildlife Coordination Act report evaluating impacts to wildlife resources from water resource programs (Appendix Q).
- Public involvement and agency correspondence (Appendix R).

Ongoing studies include geotechnical evaluation of several possible additional borrow sources in the near vicinity of the currently proposed Petit Bois OCS borrow site to determine if quantities of suitable sand may also be in these areas. If suitable, cost-effective sites are identified as a result of these investigations, this information will be included in the final SEIS.

2. Purpose and Need

In 2005, Hurricanes Cindy, Katrina, and Rita caused an unprecedented level of destruction within the Gulf Region of the U.S., most notably in Texas, Louisiana, and Mississippi. During Hurricane Katrina, coastal Mississippi was the point of impact of the greatest tidal surge that has hit the mainland U.S. in its recorded history (USACE, 2009a). Katrina affected more than 90,000 square miles of the Gulf Coast region, caused almost complete destruction of several large coastal communities, and seriously damaged numerous others. The tremendous storms devastated the physical, natural, and human environments of the region.

In response, the U.S. Congress directed the USACE in 2005 to initiate two important and related comprehensive planning efforts to address the devastation caused by the coastal storms of 2005: the MsCIP, and the Louisiana Coastal Protection and Restoration. Together, these two planning efforts were intended to develop systemwide solutions to assist the multi-state region of the U.S. Gulf Coast in recovering from the devastation caused by storms and providing greater resilience against future storms.

The MsCIP was authorized by the Department of Defense Appropriations Act, 2006 (P.L. 109-148), enacted December 30, 2005. The law directed the Secretary of the Army to conduct an analysis and design for comprehensive improvements or modifications to existing improvements in the coastal area of Mississippi in the interest of hurricane and storm damage risk reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes.

The comprehensive vision for the MsCIP is a coastal Mississippi that is more resilient and less susceptible to risk from hurricane and storm surge. The MsCIP PEIS evaluated an array of near- and long-term strategies intended to render the region more resilient and less susceptible to damage resulting from a variety of future coastal storms, including those equaling or exceeding the 2005 hurricanes (USACE, 2009a). The pursuit of resilience for coastal Mississippi led to the development of the Lines of Defense approach as described in Section 1.1 of the MsCIP PEIS, beginning with the offshore barrier islands and moving inland to the extent of the maximum probable surge. Within this zone both natural and manmade features are linked in a comprehensive storm damage risk reduction plan. The MsCIP PEIS further identified systemwide opportunities to promote the long-term sustainability of physical, human, and natural resources. These include restoring barrier island and mainland environments, protecting coastal environments, and reducing saltwater intrusion within the Mississippi Sound coastal environment (USACE, 2009a).

The ROD for the MsCIP PEIS included a recommendation for implementing comprehensive barrier island restoration to provide a first line of defense for reducing the vulnerability and increasing the resilience of the coastal Mississippi region against future hurricanes, storms, and storm surges; to improve barrier island habitat; and to protect the estuarine nature of water in Mississippi Sound. P.L. 111-32, enacted June 24, 2009, authorized and funded barrier island and ecosystem restoration elements, to restore historical levels of storm damage risk reduction to the Mississippi Gulf Coast.

2.1 Purpose of Proposed Action

Per the MsCIP PEIS, the purpose of the Proposed Action is to evaluate options to implement comprehensive restoration of the Mississippi barrier island system through the placement of sand to restore barrier islands and to supply sand for littoral transport. This SEIS has been prepared to evaluate the specific alternatives for sand borrow areas, placement options, engineering and design alternatives, and construction methods.

2.2 Need for Proposed Action

As described in the MsCIP PEIS and ROD, implementation of the recommended comprehensive restoration of the barrier islands is required to achieve the goals outlined in the MsCIP PEIS. The restoration of the Mississippi barrier island system is needed to:

- Protect and maintain the estuarine ecosystem of Mississippi Sound and to reduce storm damage incurred along the mainland coast of Mississippi.
- Preserve and protect the Mississippi barrier islands and their natural and cultural resources.
- Reduce erosion and land loss of the barrier islands, especially East and West Ship Islands, and Cat Island to the west.
- Enhance the long-term sand supply to the littoral drift system, which historically has maintained the Mississippi barrier islands through natural processes.

The Proposed Action evaluates various alternative means of achieving these goals.

3. Description of the Tentatively Selected Plan and Alternatives

This chapter describes the range of alternatives considered for site-specific implementation of Comprehensive Barrier Island Restoration, including an evaluation of reasonable alternatives to meet the project objective, per Council on Environmental Quality (CEQ) regulations implementing NEPA (40 Code of Federal Regulations [C.F.R.] Parts 1500 - 1508). Alternatives considered in this SEIS are tiered from the MsCIP PEIS; thus alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis in this document. The action alternatives considered include potential sand borrow locations and site-specific options for implementing restoration at sand placement locations authorized for construction. For each alternative carried forward for further consideration, a discussion of the affected environment (Section 4) and potential environmental effects (Section 5) provides a clear basis for decision-makers and the public to make an informed decision for the identification of the TSP.

Since much of the proposed project is located within the boundaries of the GUIS Mississippi unit, the alternatives are also evaluated for compliance with NPS policies. Restoration of barrier islands that have been impacted by human activities, such as dredging, is consistent with such policies. In addition, two proposed borrow sites are located outside waters of the State of Mississippi, including the Petit Bois-AL and Petit Bois Pass-OCS. Evaluation of these borrow alternatives for compliance with requirements that may be imposed by the State of Alabama or the BOEM in consideration of:

The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. Removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52), and either a direct sale or royalty payment may be charged for removal.

BOEM is the agency of the Department of the Interior tasked with managing the extraction of offshore minerals from America's OCS. While the largest component of this management is related to exploration for and development of oil and gas resources, the Bureau is also responsible for what are loosely referred to as "non-energy minerals" (primarily sand and gravel) obtained from the ocean floor. BOEM jurisdiction for leasing and regulating the recovery of minerals extends to the subsoil and seabed of all submerged lands seaward of State-owned waters to the limits of the OCS. 43 U.S.C. 1337(k)(2) allows the BOEM to negotiate, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach restoration, or coastal wetland restoration projects, or for use in construction projects funded in whole or part by or authorized by the Federal Government, without payment of fees. Any sand removed from the OCS requires review and an agreement from the BOEM.

Section 3.1 describes the TSP from the MsCIP PEIS. The TSP represents USACE's initial plan for restoration. It serves as the basis for development of the final design for implementing the authorized construction project as determined through additional detailed studies conducted under the Mississippi Barrier Island Restoration component of the MsCIP Comprehensive Plan.

Section 3.2 describes the detailed engineering and design evaluations, and alternatives analysis, conducted for three key components of restoration: sand borrow sites; sand placement sites and design; and construction methodology. Potential borrow sites were screened as part of extensive geophysical and hydrodynamic studies according to their technical feasibility, potential impacts, and efficacy for providing sand of sufficient quality and quantities required to meet the purpose of and need for the proposed project. Potential sand placement locations and designs were evaluated as part of site-specific geomorphologic, sediment transport, and hydrodynamic studies. Engineering designs were evaluated based on project stability and lifespan considerations, as well as characteristics of available sand sources. Construction method options were evaluated based on their ability to provide sufficient quantities of compatible sand of the proper mix to achieve the longest stable restoration without future maintenance. As part of the evaluation process, each construction method was screened for environmental concerns to avoid or minimize potential adverse impacts.

Section 3.3 summarizes the alternatives that were considered but were not carried forward for further analysis based on the findings of the detailed studies in Section 3.2.

Section 3.4 describes the alternatives retained for further analysis in this SEIS. Two primary alternatives are carried forward: No Action and the TSP with Borrow Site Option 4. Three additional borrow site options in support of the proposed restoration are also analyzed (Borrow Site Options 1, 2, and 3). These alternatives are evaluated in the remainder of the document.

3.1 Proposed Action, Programmatic Environmental Impact Statement of June 2009

As noted, the USACE's initial plan for restoration under the PEIS serves as the basis for development of alternative actions in this SEIS. The proposed Comprehensive Barrier Island Restoration as described in the MsCIP PEIS includes the restoration of the Mississippi barrier islands through the placement of up to 22 million cubic yards (mcy) of sand within the GUIS Mississippi unit and an undetermined quantity of sand near Cat Island. In the MsCIP PEIS, the overall recommendation to return sand to the system (Figure 3-1) included:

- Filling Camille Cut, the 3.5-mile breach in Ship Island
- Adding sand to the littoral system on east end of Petit Bois Island
- Adding sand to the littoral system on the east end of East Ship Island
- Adding sand to the littoral system on the east end of Cat Island

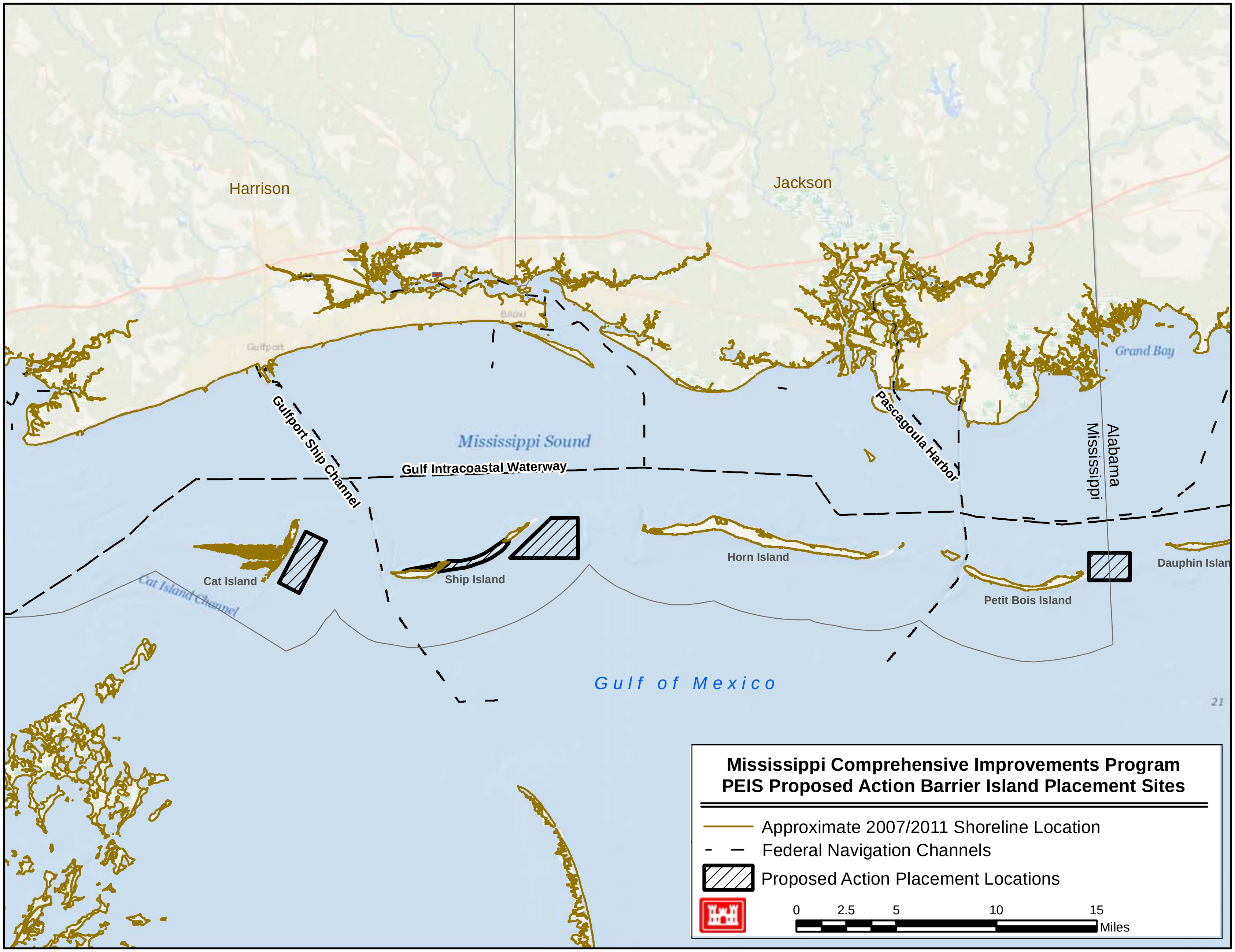

FIGURE 3-1
PEIS PROPOSED SAND PLACEMENT AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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The overarching goal of the barrier island restoration component of the MsCIP is to enhance sediment transport among the islands to mimic a natural state as much as possible given the realities of navigation channel dredging, climate change (sea level rise), and other anthropogenic activities. Initial planning with the NPS indicated that support of the project could be obtained if restoration were limited to an initial sand placement, to compensate for anthropogenic activities, with no additional maintenance thereafter, thus allowing natural coastal processes to shape the islands in the future. This complies with the NPS Management Policies (2006) and Director's Order 12 2011), which allows restoration of lands disturbed by human activities and protection of significant cultural resources in NPS units.

The following sections detail the development of alternatives for barrier island restoration. These alternatives are tiered from the MsCIP PEIS and are intended to serve the original project goals while meeting the NPS Management Policies (2006) and Director's Order 12 mentioned above.

3.2 Detailed Engineering and Design Evaluations and Alternatives Analysis

All of the alternatives considered in this SEIS are based on the information presented in the Comprehensive Barrier Island Restoration Plan of the MsCIP PEIS, which included the placement of up to 22 mcy of sand within the GUIS Mississippi unit and an undetermined quantity of sand to be placed near Cat Island. These volumes of material were based on an analysis of historical dredging records between 1987 and 2007.

Based on an updated evaluation of historical dredging records from the period of initial authorization and construction of the Pascagoula Harbor navigation channel in 1897 to the present day (specified as 2010), it was determined that approximately 25 mcy of new work and maintenance material has been dredged from the channel within the active littoral zone (Appendix B). This amount is 3 mcy more than the 22 mcy specified in the authorizing MsCIP documents, which analyzed dredging records between 1897 and 2007.

Bathymetric surveys between 1917-20 and 2005-10 were compared to determine the amount of dredged material potentially placed outside the littoral zone through anthropogenic actions. It was determined that 13.1 mcy were placed outside the active littoral cell of the barrier island chain near Horn Island Pass between 1917-1920 and 2005-2010 (Appendix B).

Conservatively accounting for uncertainty in volume calculation in the sediment budget, with ranges from ± 43,500 to ± 70,000 cubic yards per year (cy/yr), with the highest uncertainty within the inlet shoal complexes, it is estimated that upwards of 19.6 mcy of material could have been removed from the MsCIP barrier island system by dredging and disposal. This deficit is assumed to be the volume of sand that needs to be added back into the barrier island system to achieve the restoration goal.

The original MsCIP PEIS evaluated a general restoration plan that included the placement of material between East and West Ship Islands to fill Camille Cut, with preliminary estimates of the volume of fill material required. For this analysis, a more detailed design was completed to identify the most effective plan for restoring the barrier island system. The options evaluated included various design configurations using varying quantities and multiple sources of sand with different median grain sizes based on historical topographic surveys, bathymetric surveys, dredging records, and a suite of hydrodynamic, sediment transport, and morphological modeling efforts.

Development of options is organized into the three key elements required for implementation of the Comprehensive Barrier Island Restoration: potential borrow sites (Section 3.2.1), sand placement evaluations (3.2.2), and construction methodology (Section 3.2.3.). A series of design and modeling steps were completed, including a preliminary desktop analysis to generally define the volume and grain size of the material needed, an analysis of the effects of multiple storm events on the initial Camille Cut design and sediment pathways in the system, and an evaluation of a refined design with a coarser fill material and lower berm elevation. Finally, an additional modeling evaluation was conducted to estimate the future morphological response of the island based on the refined design. The following sections contain a summary of the detailed engineering and design evaluations.

The MsCIP PEIS compared several barrier island restoration alternatives based on contributions of each alternative to elements comprising the System of Accounts (National Economic Development, Regional Economic Development, Other Social Effects, and Environmental Quality), risk and uncertainty, and stakeholder preference (Engineer Regulation 1105-2-100). At the programmatic level, the initial analysis of alternatives assumed that borrow areas would be available within the immediate area and that the studies conducted for this SEIS would be used to further evaluate potential sources.

3.2.1 Potential Borrow Sites

To identify specific potential borrow sites for barrier island restoration, alternative locations were evaluated in this SEIS based on the following criteria:

- Sufficient sand quantity and compatibility with placement areas in terms of grain size, shape, color, and other physical characteristics
- Location outside of the active littoral transport system
- No significant adverse wave focusing or negative impact to the transport system following removal
- Cost-effective to obtain and transport sand to the placement site
- Compatible with NPS management policies and objectives

Sand texture (grain size, percent fines, angularity) and color characteristics were carefully considered during project design based on the stability expected in the restored areas, project longevity without future maintenance, and aesthetic qualities of the restoration. Ideally, sand used for island restoration would have essentially the same physical characteristics as the sand on the islands, so it would have nearly the same gradation, particle shape, and color. Thus, the sand added would become part of the natural transport system and enhance the barrier island habitat.

Borrow site analysis focused on maintaining the natural littoral drift by identifying sites outside of the littoral transport system. Removal of sand from the littoral zone could accelerate erosion on the eastern end of islands within the system, which would be contrary to the goal of the barrier island restoration. Impacts to wave propagation also were considered when identifying borrow sites.

The cost-effectiveness of borrow sites was evaluated based on the estimated site-specific costs of dredging and transporting material. Borrow sites were evaluated based on the likelihood of impacts on biological resources, including essential fish habitat (EFH) and critical habitat for threatened or endangered species.

Identification of potential borrow sites involved two primary investigations: beach sand compatibility investigations as described in Section 3.2.1.1, and sand borrow site investigations as described in Section 3.2.1.2. Beach sand samples were collected to quantify and qualify native sand material on the barrier islands. The results of these samples were compared to data from sediment surveys of potential sand borrow areas to identify suitable sources of sand for restoration.

3.2.1.1 Beach Sand Compatibility Investigations

The initial step in identifying sand borrow areas was to characterize the beach sand on the barrier islands for comparison with sand from the prospective borrow sites. To determine compatibility requirements for any sand placed within GUIS boundaries, samples of beach sand were taken at several locations in 2006, 2009, and 2010 (Appendix A). The samples were analyzed for color, angularity, grain size (based on diameter), and gradation (Table 3-1). In addition, transects were sampled across two of the islands and composite samples were taken to depths of several feet in 2010 (Table 3-2 and Appendix A). The samples were collected to determine the variability of grain sizes across the islands and variability with depth.

Most of the sand on the Mississippi barrier island beaches is light gray, and subangular to rounded in shape, with a median particle diameter (D50) ranging from 0.30–0.51 millimeter (mm) (Table 3-1). Sand distributed across the islands tends to exhibit greater variation in D50 grain size with depth, ranging from 0.21–0.48mm as indicated by sampling below the surface at West Ship Island (Table 3-2). Composite samples to depths of -4 or -5 feet at West Ship Island have D50 grain size ranging from 0.27–0.37mm.

For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Other material was considered provided that the overfill ratio, which is a principal value in comparing the general suitability of fill material, as a function of grain size compatibility, was equal to or less than 1.3.

TABLE 3-1
Summary of Beach Sediment Surface Sampling for Compatibility Comparisons

Locations[a]	Years[b]	Description	Typical Color[c]	D50 Grain Size (mm)[d] Range
Cat Island				
East shore of north spit; east shore of south spit	2009	Fine-grained sands; Subangular to rounded	Light gray	0.31–0.33
West Ship Island				
North beach at pier; central portion of island; south beach; boat dock on north shore; end of boardwalk, south shore; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded; some dark particles on central part of island and south beach	Light gray; gray; dark gray; light brownish gray	0.30–0.47
Island Transect	2010	Poorly graded sand		0.21–0.45
East Ship Island				
North beach; south beach; west tip; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded; some organic peat on south beach	Light gray; black (peat)	0.32–0.32
Horn Island				
North beach; south beach; boat dock on north shore; end of path from boat dock on south shore; eastern end on north shore; eastern end on south shore; sand spit east of eastern end of island	2006, 2009	Medium poorly graded sand; subangular to rounded	Light gray; gray; olive gray; white	0.33–0.51
Island Transect	2010	Poorly graded sand		0.28–0.48
DA-10/Sand Island				
South shore	2009	Subangular to rounded	Light gray	0.33
Eastern side, center, western side	2011	Medium to fine sand; subangular to rounded	NA	0.30–0.39
Petit Bois Island				
North beach; south beach; north shore in center of island; south shore in center of island; east end on north shore; east end on south shore	2006, 2009	Medium poorly graded sand; subangular to rounded	Light gray	0.34–0.39

Source: Appendix A

[a] See sample location maps in Appendix A of the Geophysical Report, which is Appendix A of this SEIS.

[b] 2006 samples collected by USACE analyzed for color and angularity; 2009 samples collected by USACE and NPS analyzed for color and angularity, and tested for grain size at a contract engineering laboratory; 2010 samples tested for grain size.

[c] Munsell color of wet or dry sediment; if more than one color, presented in decreasing frequency of observation.

[d] Range and average provided if more than one sample; sample value provided if single sample.

TABLE 3-2
Summary of Beach Sediment Profile Sampling at West Ship Island

Depths from 0.0–5.0 feet	Depth of Sample (ft)	D50 Grain Size (mm)
West Ship Island (WSI-5-10) [a]	0.0–1.5	0.37
	1.5–3.0	0.34
	3.0–4.5	0.32
West Ship Island (WSI-12-10)	1.0–2.0	0.33
	2.0–3.0	0.27
	3.0–4.0	0.28
West Ship Island (WSI-13-10)	1.0–2.0	0.34
	2.0–3.0	0.27
	3.0–4.0	0.27
	4.0–5.0	0.32

Source: Appendix A

[a] See Figure 3.2.3.3 in Appendix A of Appendix A to this SEIS

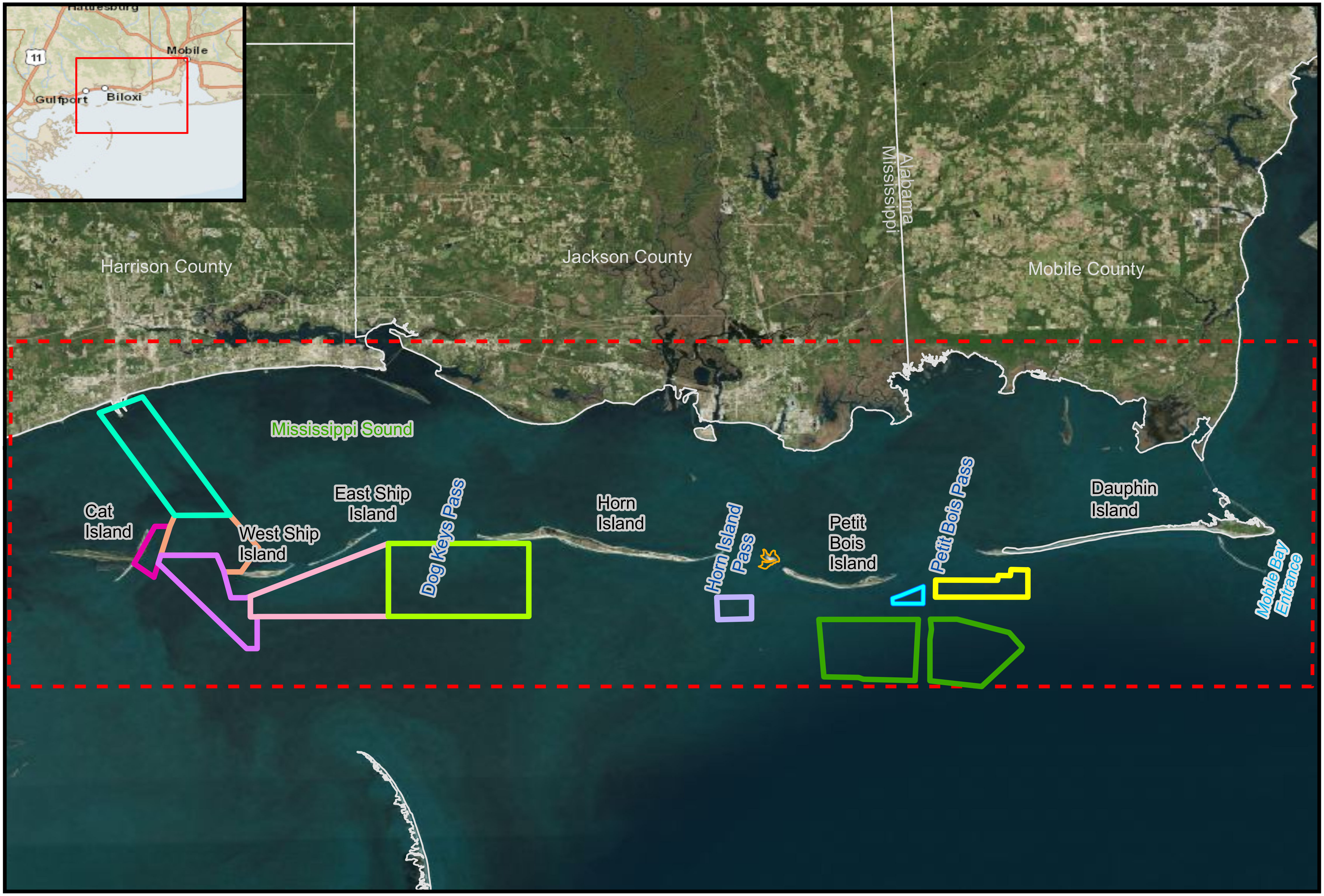
3.2.1.2 Borrow Sites Investigation and Analysis

Under an interagency agreement, the USGS conducted an extensive geophysical program to locate and quantify potential sand borrow locations (Twichell et al., 2011). Review of geophysical documents and records led to identification of areas deemed geologically conducive to the presence of large sand deposits. The USGS, in collaboration with USACE, surveyed much of the inner shelf offshore of the Mississippi barrier islands to define the shallow stratigraphy of the region and assess the distribution and extent of sediment deposits that could be dredged for the large volume of material needed for restoration. Geophysical and bathymetric surveys collected by the USGS and vibracores collected by USACE were integrated to help identify potential sand sources. The samples, collected using a vibracore sampler with a 20-foot core barrel, allowed geologists to classify sand and to make initial observations of grain size and color.

Boring locations were selected in 10 areas identified near the barrier islands, from Cat Island eastward to Petit Bois Pass (Figure 3-2):

- Gulfport Channel
- Saint Bernard Shoals
- Mississippi Sound
- Cat Island
- Ship Island Pass
- Ship Island
- Dog Keys Pass
- Horn Island Pass
- DA-10/Sand Island
- Petit Bois Pass

In addition to the 10 borrow locations investigated as part of the original geophysical investigation, sand from upland disposal sites in the Lower Tombigbee River was evaluated (*Note:* These sites are not shown in Figure 3-2 because of distance from restoration sites). The upland borrow source was included in the evaluation because initial studies during the PEIS found significant quantities of sand available from several disposal areas along the river. Furthermore, these sites are close to their disposal capacity, so the beneficial reuse options were considered. Initial concerns about use of the material focused on the potential color of the material and grain size compatibility with the placement areas.



Cat Island
Dog Keys Pass
Gulfport Channel
MS Sound
Ship Island
Ship Island Pass
Sand Island DA-10
Horn Island Pass
Petit Bois - Alabama
Petit Bois - Mississippi
Petit Bois - Outer Continental Shelf

FIGURE 3-2
SAND BORROW MATERIAL INVESTIGATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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In 2012 and early 2013, USACE conducted more investigations to further evaluate potential sand quality in the Petit Bois Pass (including Petit Bois Alabama [PBP-AL], Petit Bois Mississippi [PBP-MS], and Petit Bois Outer Continental Shelf [PBP-OCS]) and the Horn Island sites. Field surveys were completed using vibracores, and samples were again analyzed for grain size, percent fines, and color. Results of these investigations (see Appendix A and Table 3-3) provide the basis for evaluating the compatibility of sand in potential borrow area locations (in terms of color, shape, percent fines, and size characteristics) with sands on barrier island beaches (Tables 3-1 and 3-2).

As noted, optimum borrow sand was identified as well sorted to poorly sorted subangular, light gray to gray in color, with median grain size greater than 0.28mm and percent fines less than 10 percent. Several sites contain sand acceptable for barrier island restoration, whereas others lack suitable material of desired grain size, silt content, shape, or color. Mean grain size of material at potential borrow sites generally is finer than existing island sand, with the exception of Petit Bois Pass (all sites), Horn Island, and DA-10/Sand Island borrow sites. However, mixing sand of different grain sizes from otherwise suitable borrow sites can achieve the compatibility and stability of fill required for restoration, as noted in the discussion of construction alternatives in Section 3.2.3.2.

For reasons provided in Table 3-3, six borrow sites (St. Bernard Shoals, Gulfport Channel, Mississippi Sound, Ship Island Pass, Dog Keys Pass, and Lower Tombigbee River Upland disposal sites) were evaluated as not feasible, and seven (Cat Island, Ship Island, DA-10/Sand Island, Petit Bois Pass–MS, Petit Bois Pass–AL, Petit Bois Pass-OCS, and Horn Island Pass) were evaluated as feasible. These are shown in Figure 3-3 and described in Table 3-3.

Cat Island

Potential borrow sites were investigated to the east of Cat Island. Geophysical surveys indicated the availability of extensive sand deposits in this area that could provide 2.1 mcy of sand for placement at Cat Island. Average grain size in the borrow area (D50 of 0.20mm) is smaller than in the native beach but deemed suitable for the placement site, and material is predominantly light gray in color. The borrow area is approximately 282 acres in size and material is an average of 5 feet thick. Water depth over the area ranges from -12 to -14 feet North American Vertical Datum of 1988 (NAVD88) (Figure 3-4). Although the area is within designated critical habitat (Unit 8) for the federally threatened Gulf sturgeon and has a smaller grain size than desired, it is near the placement area on Cat Island, and the volume necessary for restoration would be small relative to the widespread availability of sand in this area. East and West Ship Islands and the shoal system to the south help to shelter the area from stronger, more energetic waves coming from the south and southeast, but there is the potential for moderate focusing of waves from the north and northeast along Cat Island. Because of the shallow (< 30 feet) nearshore location of the potential borrow areas, hydrodynamic modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or adversely affect the transport system. Additional evaluations of the impact to Gulf sturgeon critical habitat (GSCH) were also conducted. The borrow area design is configured to prevent significant adverse impacts to the transport system and the use of this site would not impact or adversely modify critical habitat or threaten the continued existence of the protected species.

TABLE 3-3
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
Locations Not Carried Forward				
St. Bernard Shoals	Sufficient quantities available.	Too dark gray in color and fine-grained.	Area crossed by numerous pipelines, which would restrict dredging.	Site too distant from placement sites; incompatible color and grain size.
Gulfport Channel	Very limited amounts of sand over scattered areas.	Silts or clays not project compatible.	Areas outside actual shipping channel located within Gulf sturgeon designated critical habitat.	Not feasible because of lack of suitable material (predominantly silt and clay).
Mississippi Sound	Some areas near West Ship Island with large sand deposits.	Grain size (0.16–0.21 mm, with mixed silts and clay) too fine, clay overburden.	Entire deposit located within Gulf sturgeon designated critical habitat.	Not feasible because of fine grain size; located in designated critical habitat for Gulf sturgeon.
Ship Island Pass	Limited sand deposits; located in northern portion of pass in shoals.	Grain size (0.13–0.19 mm) too fine; 8 to up to 20 feet of muddy overburden.	Entire deposit located within Gulf sturgeon designated critical habitat.	Not feasible because of fine grain size; would affect critical habitat.
Dog Keys Pass	Sand deposits located within active littoral transport zone of barrier islands.	Grain size (0.16–0.23 mm) too fine.	Located within Gulf sturgeon designated critical habitat.	Not feasible because of fine grain size; would affect critical habitat; location in active littoral zone.
Lower Tombigbee River Upland Disposal Sites	Approximately 2 mcy available from two upland disposal sites.	Grain size acceptable (D50 of 0.30 mm); incompatible color (reddish-pink hue).	Located in existing upland disposal area.	Not feasible because of transport distances (78 and 92 miles from the mouth of the Mobile River) and sand color.
Locations Carried Forward				
Cat Island	2.1 mcy of sand deposits located off the east beach.	Grain size suitable for placement (D50 of 0.20 mm); predominant color light gray.	Some potential for focusing of waves from the north and northeast; located within Gulf sturgeon designated critical habitat on the West Bank platform; and outside of the active littoral transport zone	Feasible because of adequate sand volume; possibility of shallow excavation; could avoid Gulf sturgeon impacts and minimize wave focusing.
Ship Island	22 mcy of sand available (Ship Island Borrow Area Option 1) south of the island; 2 subareas identified: Ship Island Borrow Area Option 2 includes 8.7 mcy of sand; and Ship Island Borrow Area Option 3 includes 1.2 mcy of sand.	Grain size D50 = 0.21 mm); predominant color light gray.	Moderate potential for adverse shoreline impacts due to wave refraction; part of the 22 mcy is within Gulf sturgeon designated critical habitat; area located southeast of Loggerhead Shoal and outside of the active littoral transport zone.	Feasible; close to placement areas; grain size is finer than desired; Ship Island Borrow Area Option 3 avoids GSCH, and minimizes wave focusing.

TABLE 3-3
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
DA-10/Sand Island	5.1 mcy of sand deposits associated with historical dredged material disposal area available for use. Sand deposits located outside the most active littoral system.	DA-10/Sand Island Borrow Area Option 1 includes 5.1 mcy of light gray sand, with D50 = 0.33 mm. DA-10/Sand Island Borrow Area Option 2 includes 3.7 mcy of light gray sand, with D50 = 0.32 mm.	Within Gulf sturgeon and piping plover *(Charadrius melodus)* designated critical habitat; upland portion of the area (Sand Island) is used by nesting shore birds; site is located within the Horn Island Pass shoal complex.	Feasible; within Gulf sturgeon and piping plover critical habitat; active dredge material disposal site; DA-10/Sand Island Borrow Area Option 1 would affect 7.87-acre ponded wetland but would protect more piping plover habitat and would reduce wave energy penetrating the Sound by keeping in place the southern shoreline; DA-10/Sand Island Borrow Area Option 2 would avoid the wetland.
Petit Bois Pass-Alabama East (PBP-AL East)	Up to 13.1 mcy of sand available, south of Petit Bois Pass.	PBP-AL East Option 1 has 11.7 mcy of light gray to white sand, with D50 = 0.33 mm. PBP-AL East Option 2 has 13.1 mcy light gray to white sand, with D50 = 0.33 mm.	Moderate potential for adverse shoreline impacts due to wave refraction; outside (south of) Gulf sturgeon designated critical habitat; area located south and southeast of the Petit Bois Pass shoal system and outside the active littoral transport zone.	Both options feasible; PBP-AL East Option 2 offers more sand volume.
Petit Bois Pass-Alabama West (PBP-AL West)	4.3 mcy of sand initially identified south of Petit Bois Pass; 2.9 mcy of sand identified as feasible for use.	PBP-AL West Option 1 has 4.3 mcy of light gray to white sand, with D50 = 0.32 mm. PBP-AL East Option 2 has 2.9 mcy light gray to white sand, with D50 = 0.28 mm	Moderate potential for adverse shoreline impacts due to wave refraction; outside (south of) Gulf sturgeon designated critical habitat; area located south and southeast of the Petit Bois Pass shoal system and outside the active littoral transport zone.	PBP-AL West Option 2 feasible; avoids pipeline crossings and reduces potential impacts of bathymetric changes along the pipeline as a result of wave focusing.
Petit Bois Pass—Mississippi (PBP-MS)	2.0 mcy of sand available west of pass	Sand is light gray in color with grain size of D50 = 0.31 mm.	Moderate potential for adverse shoreline impacts due to wave refraction; outside (south of) Gulf sturgeon designated critical habitat; area located south of the Petit Bois Pass shoal system and outside the active littoral transport zone.	Feasible; optimum grain size; outside Gulf sturgeon habitat
Petit Bois Pass—Outer Continental Shelf (PBP-OCS)	4.9 mcy of sand available,	Sand is light gray in color; D50 grain size ranges from 0.28–0.33 mm.	Located outside (south of) Gulf sturgeon designated critical habitat and outside the active littoral transport zone.	Feasible due to adequate sand volume, optimum grain size; outside Gulf sturgeon habitat.

TABLE 3-3
Summary of Potential Borrow Material Locations

Survey Area	Sand Availability	Sediment Characteristics	Environmental Considerations	Summary of Feasibility as Borrow Source
Horn Island Pass	Sand disposal mound from historical bar channel dredging located south of pass; about 3.2 mcy of sand available.	D50 ranges from 0.27–0.30 mm; predominant color gray.	Located outside (south of) Gulf sturgeon designated critical habitat; area located south of the Horn Island Pass ebb tidal shoal and outside the active littoral transport zone.	Feasible; small volume, but optimum grain color and size, outside Gulf sturgeon habitat.

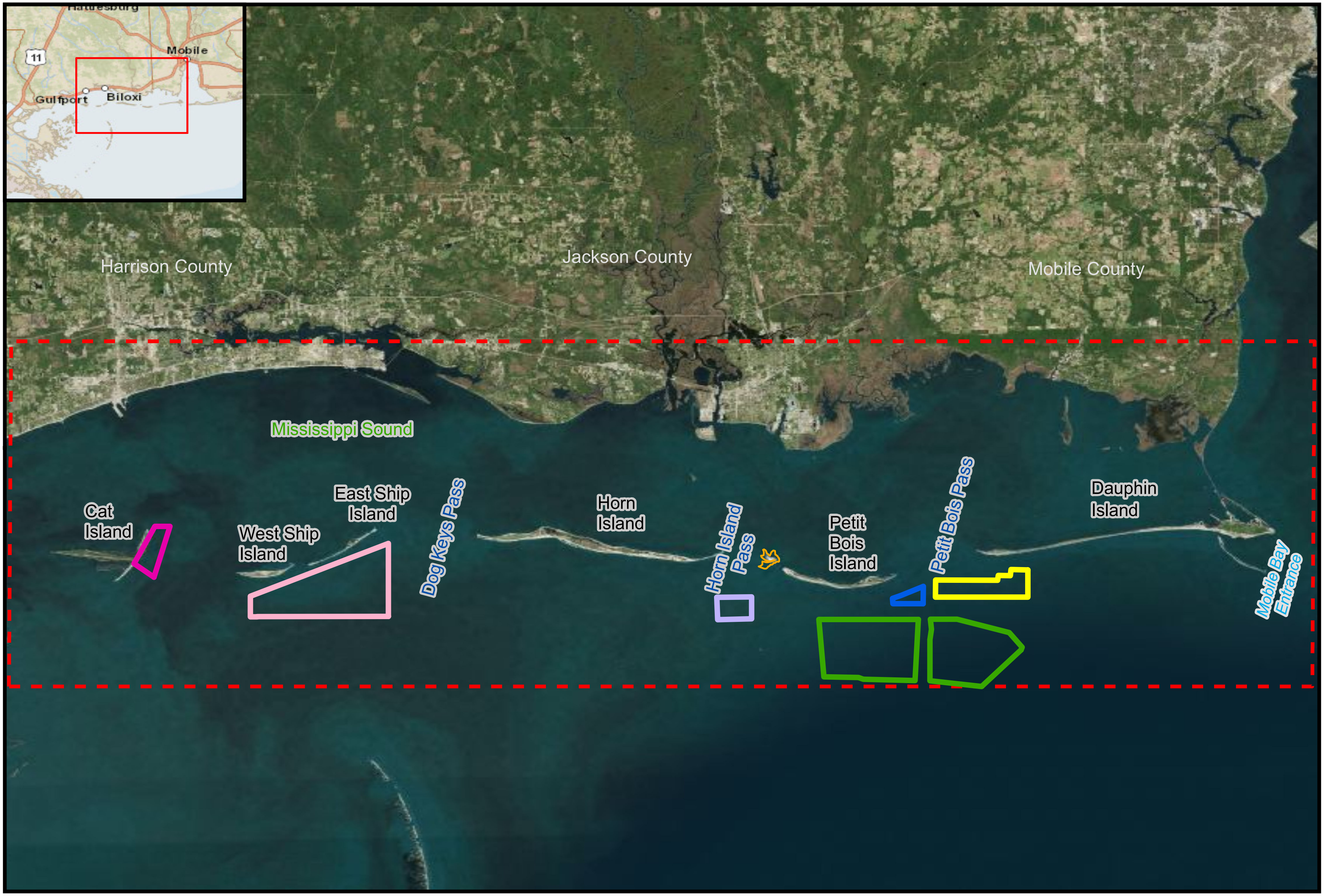
Source: Appendix A.

Ship Island Borrow Area(s)

Geophysical surveys and borings identified an initial deposit of 22 mcy in the area south of Ship Island, with an average cut thickness of 8 feet. Within the Ship Island borrow site, three potential borrow areas were identified: Ship Island Borrow Area Option 1, Ship Island Borrow Area Option 2, and Ship Island Borrow Area Option 3 (Figure 3-5). Ship Island Borrow Area Option 1 is located 1.5 miles south of Camille Cut and East Ship Island at a depth of approximately -28 feet NAVD88. The proximity of the sand deposit to Camille Cut and East Ship Island makes the borrow area highly favorable for the placement of sand at East and West Ship Islands. However, the sand is finer than desired (D50 of 0.21 mm), which would limit its potential use. The predominant sand color is light gray.

Further investigations identified two sub-areas of Ship Island Borrow Area Option 1 (Figure 3-5): Ship Island Borrow Area Option 2 and Ship Island Borrow Area Option 3. Ship Island Borrow Area Option 2 is 634 acres in size and contains 8.7 mcy of suitable sand. Ship Island Borrow Area Option 3 is 96 acres in size and contains 1.2 mcy of sand. Ship Island Borrow Area Option 3 is entirely outside designated critical habitat for Gulf sturgeon. Because of the shallow (< 30 feet), nearshore location of the potential borrow sites in the area, hydrodynamic modeling studies were conducted to determine whether use of this material would cause adverse wave focusing or adversely affect the transport system. The borrow area design was configured to prevent significant adverse impacts to the transport system. Appendix C contains details of these studies. The modeling evaluation indicated that using a subset of the entire 22 mcy of sand available would not adversely affect the long-term overall morphological development of Ship Island.

Based on the proximity of the site, potential sand volume and grain size, and limited potential for impact on critical habitat, Ship Island Borrow Area Option 3 is considered the most feasible of the Ship Island borrow areas.



Cat Island
Ship Island
Sand Island DA-10
Horn Island Pass
Petit Bois - Alabama
Petit Bois - Mississippi
Petit Bois - Outer Continental Shelf

FIGURE 3-3
PROPOSED BORROW MATERIAL LOCATIONS
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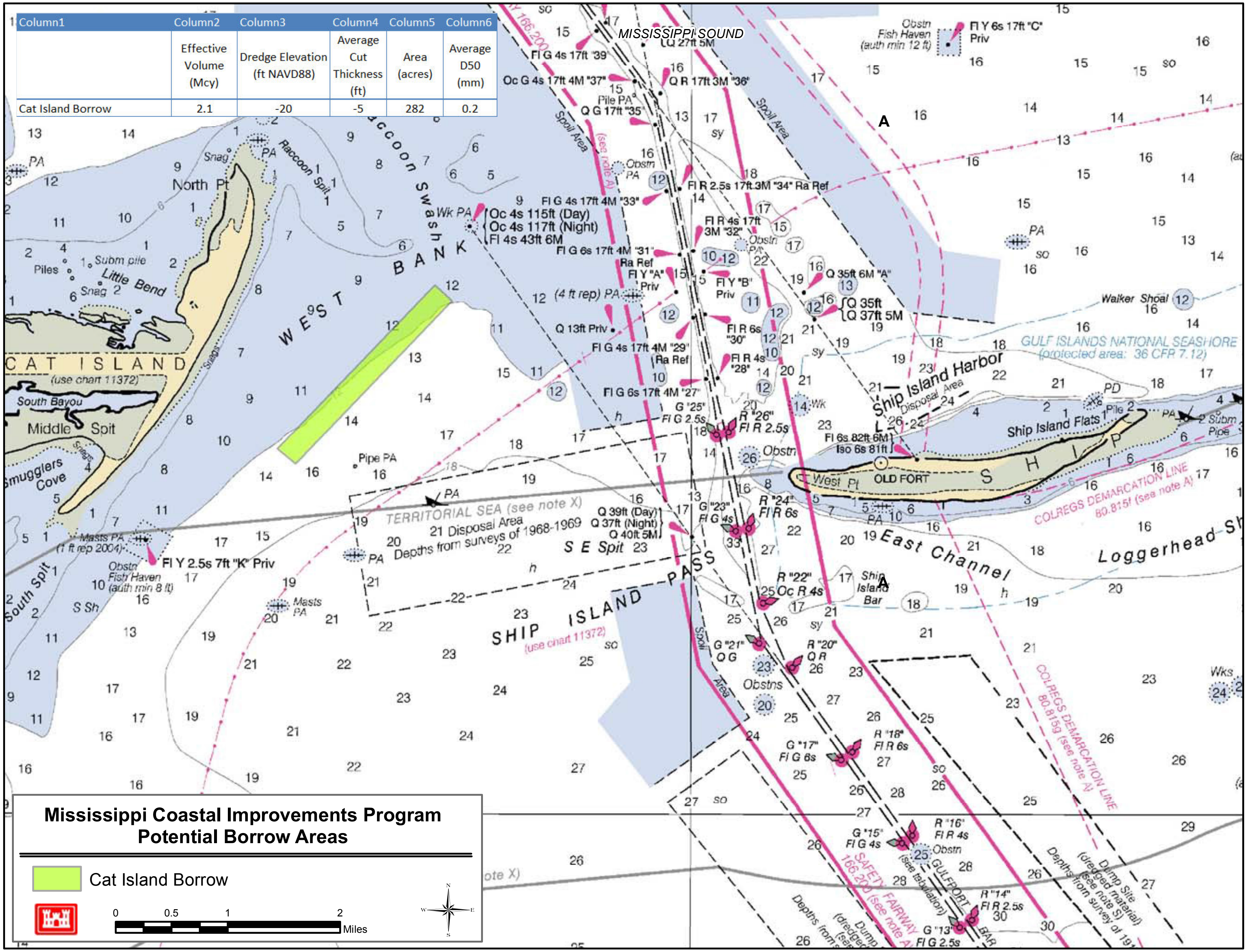

Column1	Column2	Column3	Column4	Column5	Column6
	Effective Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Area (acres)	Average D50 (mm)
Cat Island Borrow	2.1	-20	-5	282	0.2

NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-4
CAT ISLAND BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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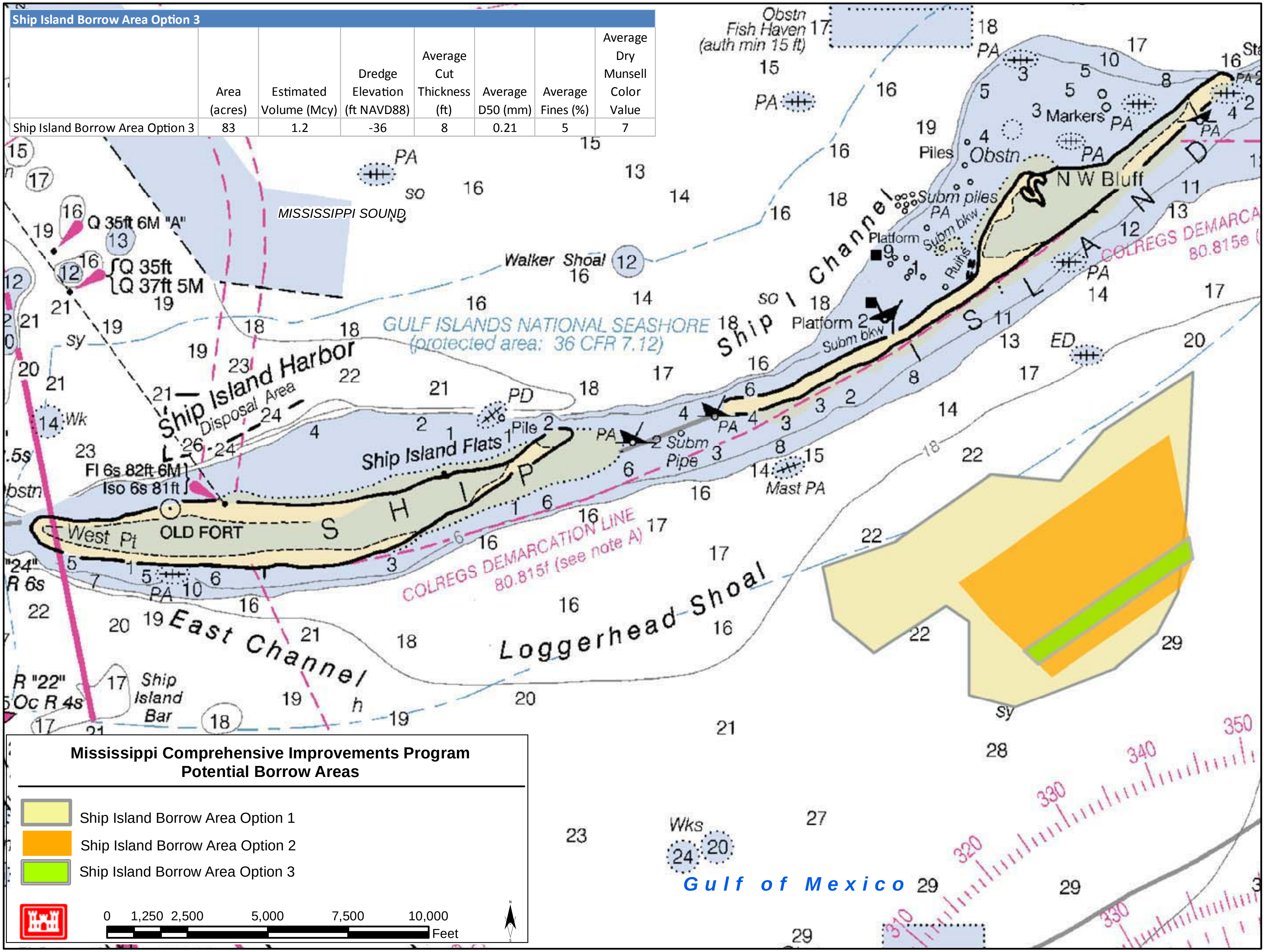
Ship Island Borrow Area Option 3	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
Ship Island Borrow Area Option 3	83	1.2	-36	8	0.21	5	7



NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-5
SHIP ISLAND BORROW AREA OPTIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Horn Island Pass Borrow Area(s)

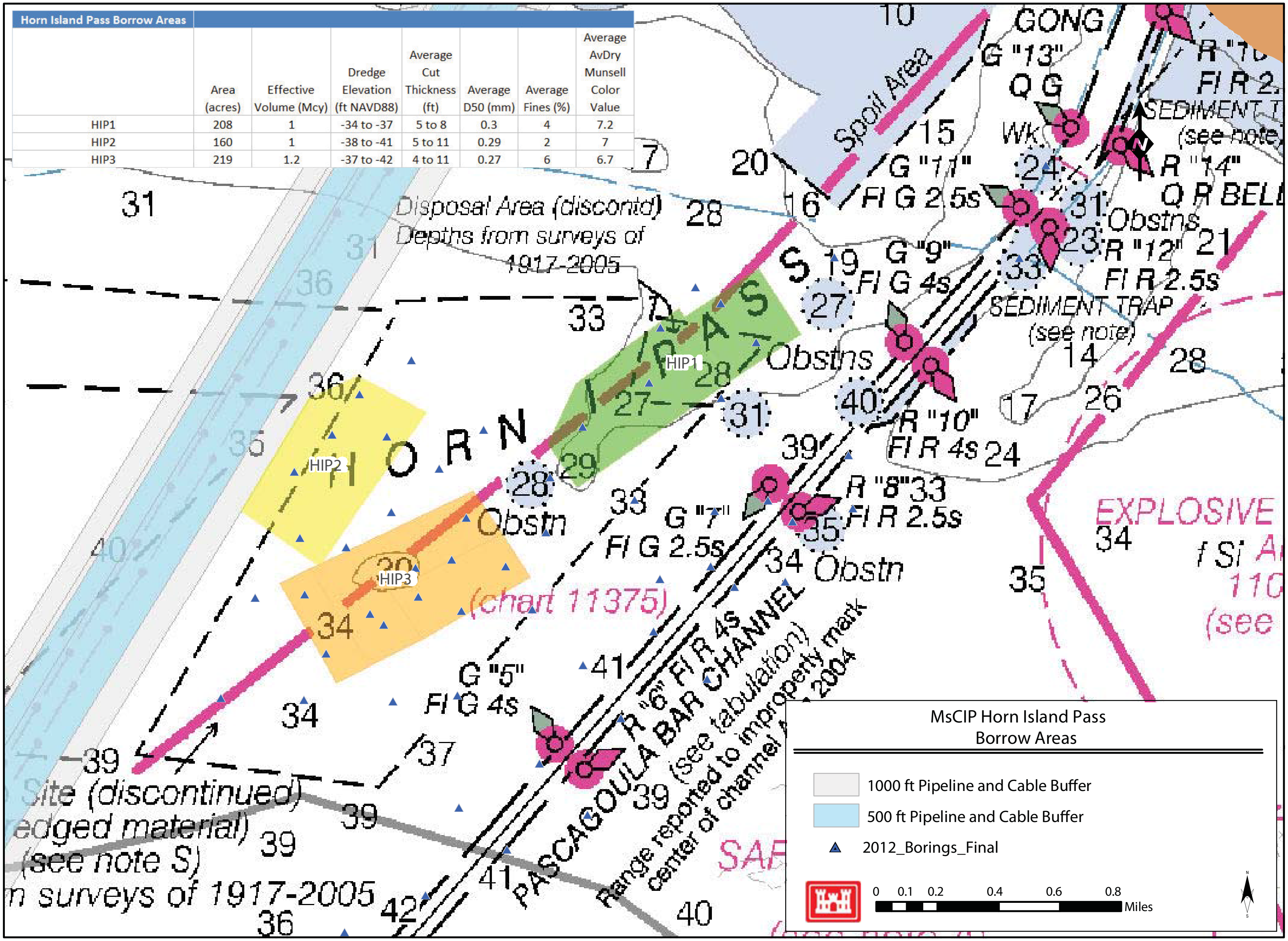
The Horn Island Pass borrow site lies immediately west of the Pascagoula Harbor entrance channel (Figure 3-6). The sediment mounds present there were formed by past disposal of dredged material from the Pascagoula Bar Channel section of Horn Island Pass. The ambient water depths range from 27–40 feet. Estimated available volume from the borrow area is 3.2 mcy, and the D50 is 0.28 mm. The Horn Island Pass borrow areas combined are 587 acres with cut elevations of -34 to -42 feet NAVD88 and cut thicknesses ranging between 4 and 11 feet. Three obstructions near the borrow sites are marked on NOAA charts. The sites were buffered with 200 feet in addition to the specified buffer, as indicated on the latest NOAA map. In addition, two known pipelines are located to the east. A 1,000-foot buffer was maintained around the known pipelines. Excavation would consist of removing disposal mounds to surrounding depths; therefore, any potential wave focusing would likely be minor.

DA-10/Sand Island Borrow Area(s)

This potential borrow site, within the GUIS NPS boundary, is a dredged material disposal location used for material dredged from the Pascagoula Harbor Federal Navigation Project between Horn and Petit Bois islands. DA-10/Sand Island is on the west side of the channel. Although this area is within the active littoral zone, material has been placed in the northern part of the specified disposal area such that transport is not conducive to feeding the natural island sand transport system. The specified disposal area is 940 acres in size, including the 165-acre island locally known as Sand Island. Sand Island, which has been created through the disposal of dredged material, is an NPS resource that includes recreational area for NPS visitors, approximately 23.5 acres of scattered vegetated wetland habitats (the largest of which is a 7.8-acre ponded wetland), and shorebird habitat.

Elevations at the site range from 18 to -10 feet NAVD88. Geotechnical surveys have identified 5.1 mcy of suitable quality sand, with favorable grain size (D50 = 0.33 mm) to remove from this location. DA-10/Sand Island is within the area designated as critical habitat for the Gulf sturgeon and the piping plover, but it is an active dredged material disposal site.

Two potential borrow options within DA-10/Sand Island were identified. Borrow Area Option 1 is 357 acres in size, including 105 acres of Sand Island. Sand would be removed to a depth of approximately -12 feet NAVD88 (Figure 3-7). Because of the shallow (< 30 feet) nearshore location of the potential borrow material in the area, hydrodynamic and sediment transport potential modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or adversely affect the transport system. The borrow area design was configured to prevent significant wave focusing or adverse impact to the transport system. Details of these studies are included in Appendices B, D, E, and F. The southern part of Sand Island is proposed to be left in place to minimize potential changes to waves on the leeward side of the island and to continue to provide shorebird habitat (see Sections 4 and 5).

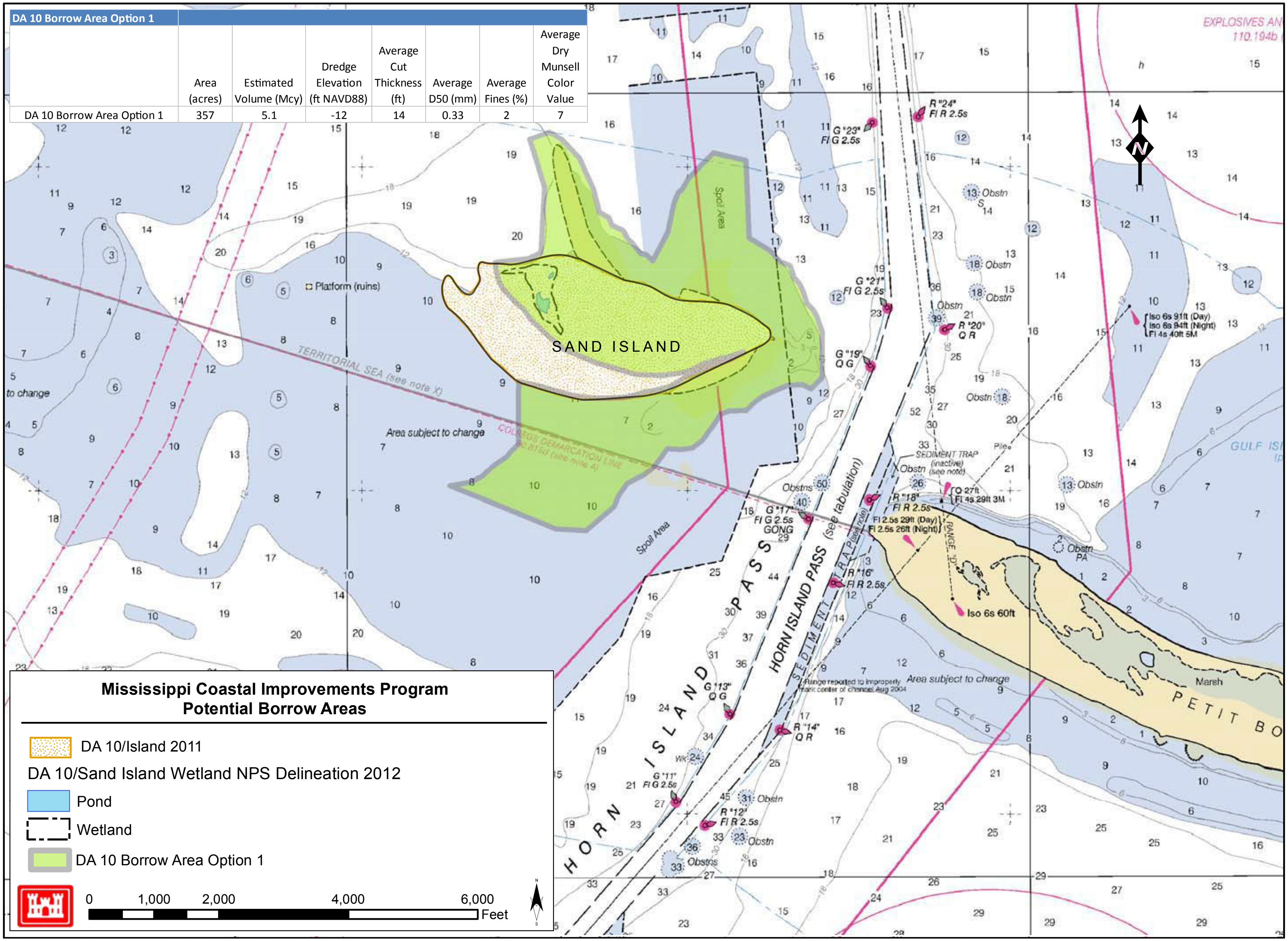


Horn Island Pass Borrow Areas	Area (acres)	Effective Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average AvDry Munsell Color Value
HIP1	208	1	-34 to -37	5 to 8	0.3	4	7.2
HIP2	160	1	-38 to -41	5 to 11	0.29	2	7
HIP3	219	1.2	-37 to -42	4 to 11	0.27	6	6.7

NOAA Chart 11373
Source Data: NOS surveys 1970 to 1989

FIGURE 3-6
HORN ISLAND PASS BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

DA 10 Borrow Area Option 1	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
DA 10 Borrow Area Option 1	357	5.1	-12	14	0.33	2	7



NOAA Chart 11375
Source Data: NOS surveys 1970 to 1989

FIGURE 3-7
DA-10/SAND ISLAND BORROW SITE OPTION 1
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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- Option 2 (Figure 3-8) was developed to avoid removal of a 7.87-acre ponded wetland inadvertently created through dredged disposal practices at the Pascagoula Harbor Navigation Channel. Use of Option 2 would involve using approximately 58 acres of the eastern part of Sand Island above MLLW while seeking to keep 125 acres of the western segment above MLLW in place. This area includes the lower berm elevation (+5 feet NAVD88) along the southern shoreline for bird habitat and the higher vegetated elevations upwards of +18 feet NAVD88 associated with an existing ponded wetland. Option 2 is approximately 304 acres in size, of which 58 acres are above MLLW and 246 acres are below MLLW. Approximately 3.7 mcy of sand would be removed to a depth of -12 feet.

Petit Bois Pass Borrow Area(s)

Within the Petit Bois Pass borrow site (Figure 3-9), the inshore PBP-AL and PBP-MS locations and the PBP-OCS location were investigated. Each is discussed below.

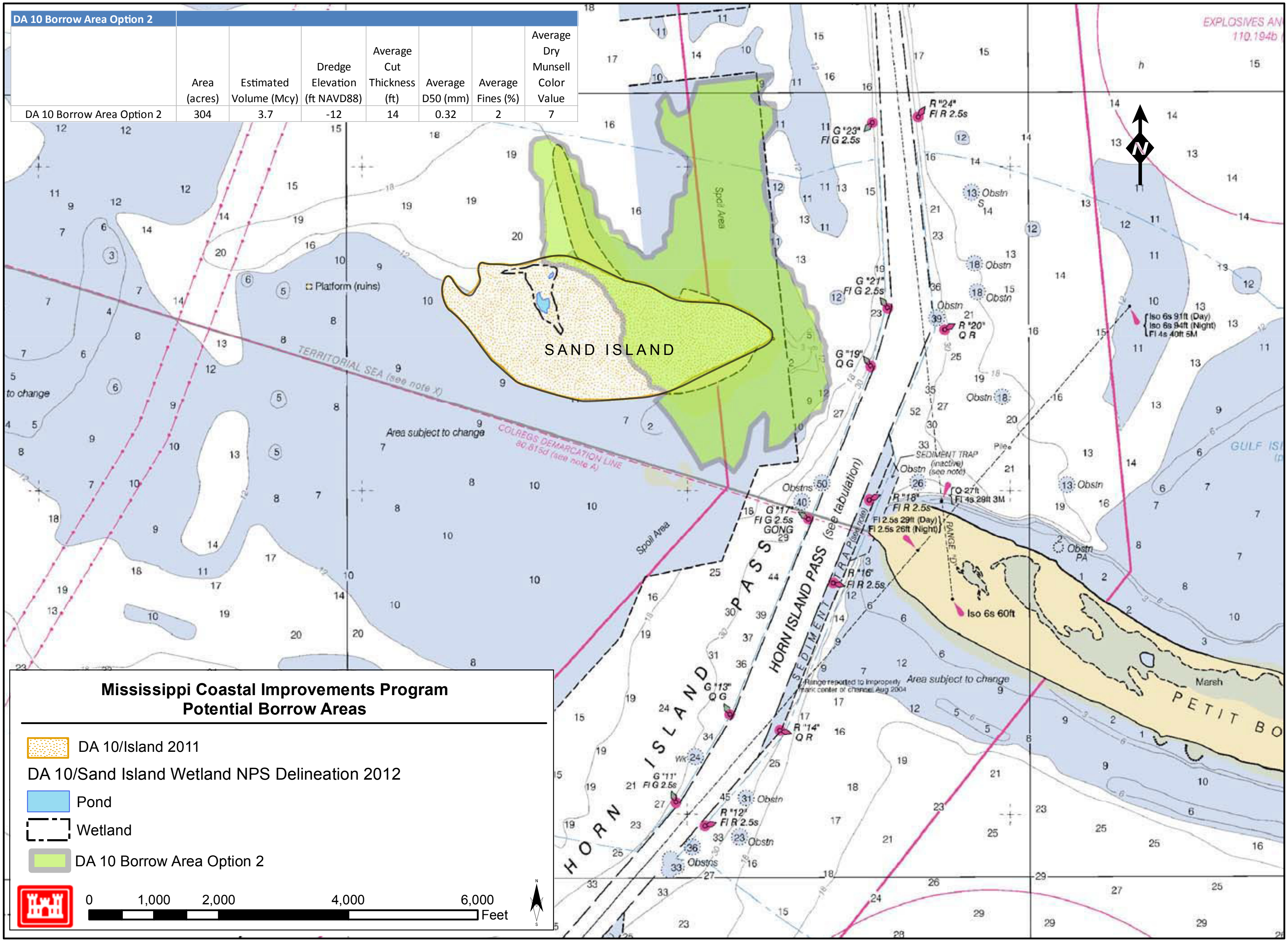
PBP-AL Borrow Area(s)

The initial PBP-AL location extends from Petit Bois Island in Mississippi, east to Dauphin Island in Alabama. Geophysical surveys indicated that large deposits of sand are present in the area south of the main pass extending 3 miles offshore (Figure 3-10). Based on the results of borings, 16 mcy of suitable sand were found in two separate zones: PBP-AL West Option 1 and PBP-AL East Option 1. PBP-AL West Option 1 is approximately 587 acres in size and contains 4.3 mcy of sand (Figure 3-10). PBP-AL East Option 1 is approximately 753 acres in size and contains 11.7 mcy of sand (Figure 3-10).

Both PBP-AL West Option 1 and PBP-AL East Option 1 contain high-quality sand, with a larger compatible grain size (D50 = 0.32 mm) and color ranging from light gray to white, but PBP-AL West Option 1 contains a higher percentage of shell fragments. The extent of the sand appears to be continuous with a shallow bar to the north that is within the littoral zone of one of the barrier islands, but its characteristics suggest it may be of fluvial origin associated with a relict river channel. This area is located outside (southeast of) GSCH. It is in water with an average depth of approximately -31 feet NAVD88 and is 2-2.5 miles southwest of Dauphin Island.

Because of the shallow (< 30 feet) nearshore location of the area, hydrodynamic modeling studies were conducted to determine whether disruption of the deposits would cause adverse wave focusing or adversely affect the transport system. The borrow area design was configured to prevent significant adverse impacts to the transport system. Appendix D contains details of these studies. Given the extensive shoal system to the north, most wave focusing would be broken up by the shoal.

Based on results from hydrodynamic and morphological modeling of potential impacts to adjacent pipelines, PBP-AL East Option 2 and PBP-AL West Option 2 were defined and are more feasible than PBP-AL East Option 1 and PBP-AL West Option 1 (Figure 3-10). The boundary for PBP-AL West Option 2 was established to maintain a buffer of at least 1,000 feet around known pipelines. To offset the smaller volume of sand available from PBP-AL West Option 2, compared to PBP-AL West Option 1, additional geotechnical investigations were performed in 2012 along the margins of the borrow areas. Therefore, the boundary of PBP-AL East Option 2 is larger than that of PBP-AL East Option 1, to include suitable material located further away from the pipelines. The estimated combined available volume of PBP-AL East Option 2 and PBP-AL West Option 2 is 16 mcy, and the combined area is 1,265 acres. Cut elevations vary between -32 to -48 feet NAVD88 and cut thicknesses between 3 and 18 feet.



DA 10 Borrow Area Option 2	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
DA 10 Borrow Area Option 2	304	3.7	-12	14	0.32	2	7

NOAA Chart 11375
Source Data: NOS surveys 1970 to 1989

FIGURE 3-8
DA-10/SAND ISLAND BORROW SITE OPTION 2
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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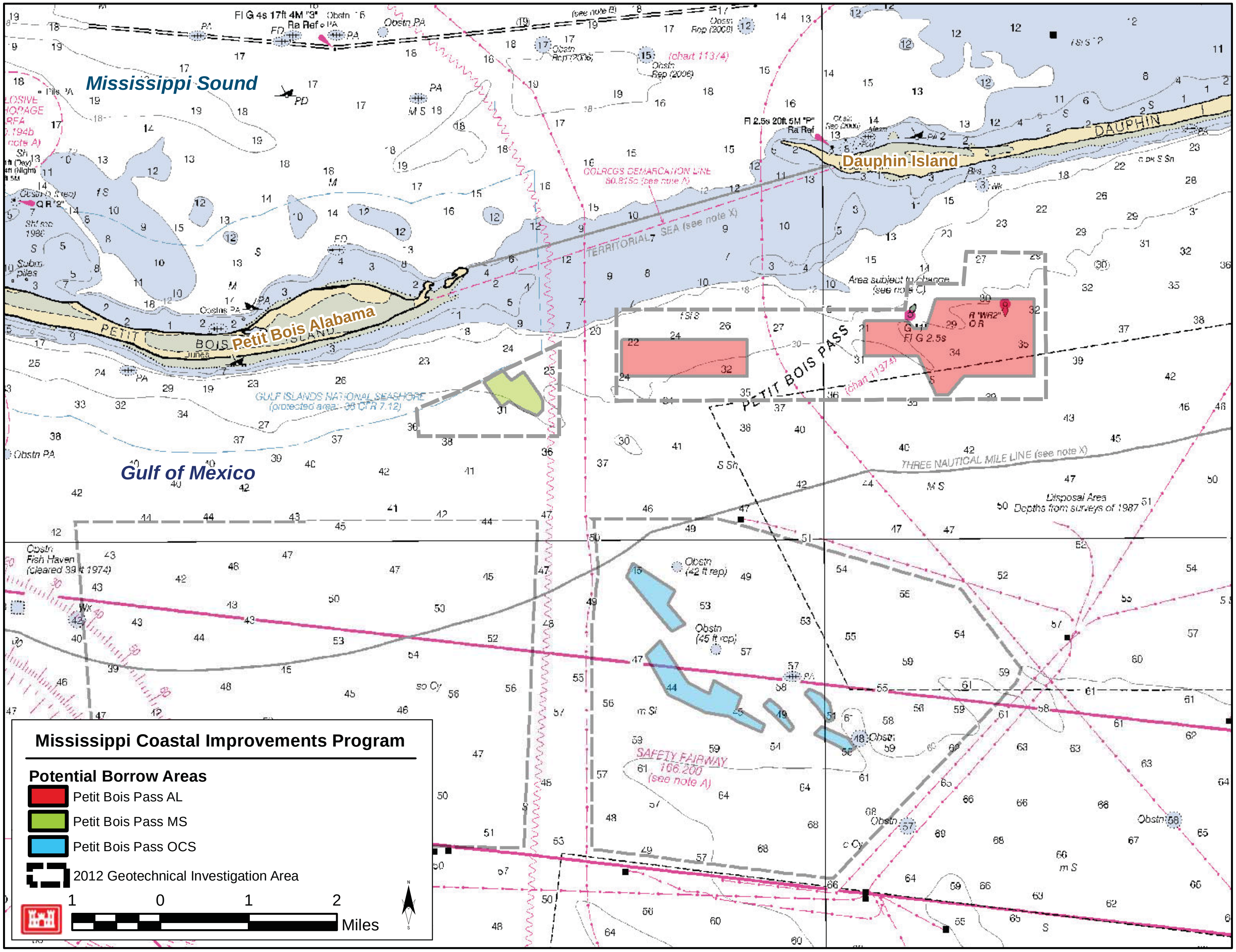
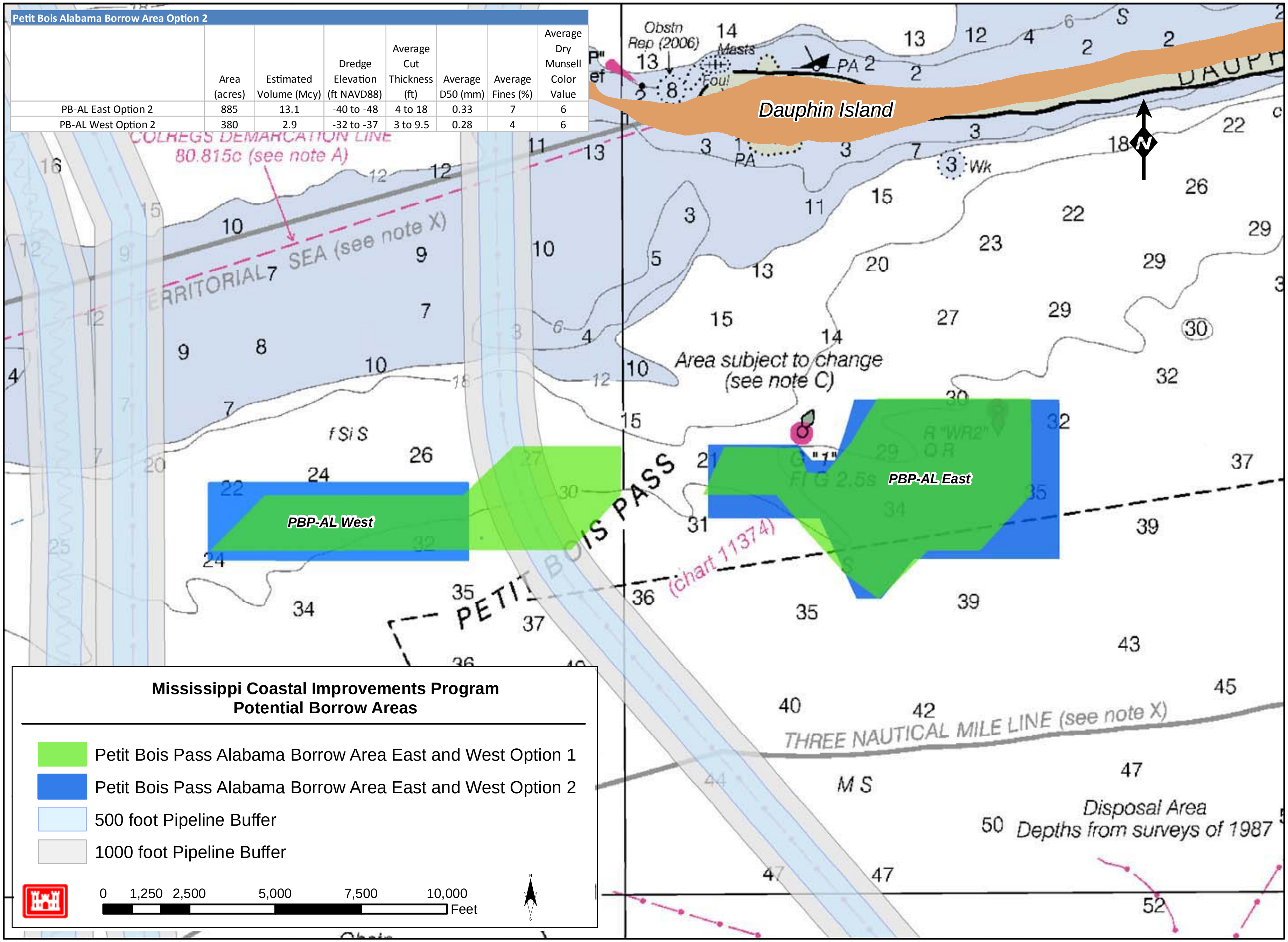


NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-9
PETIT BOIS PASS BORROW AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Petit Bois Alabama Borrow Area Option 2

	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PB-AL East Option 2	885	13.1	-40 to -48	4 to 18	0.33	7	6
PB-AL West Option 2	380	2.9	-32 to -37	3 to 9.5	0.28	4	6



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-10
PETIT BOIS PASS-ALABAMA BORROW AREA OPTIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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PBP-MS Borrow Area(s)

The PBP-MS borrow site is located about 1 mile southeast of the eastern tip of Petit Bois Island (Figure 3-11). Sand in this location has a favorable grain size (D50 = 0.31 mm). The ambient water depths range from -25 to -32 feet. Available volume is approximately 2.0 mcy. The site consists of 175 acres with cut elevations of -33 to -48 feet NAVD88 and cut thicknesses ranging between 4 and 16 feet. The site is bounded to the north and west by the NPS limits and to the east by a submerged cable and a pipeline. The cable is about 500 feet from the eastern limits of the proposed borrow area, the pipeline about 2,500 feet.

PBP-OCS Borrow Area(s)

The PBP- OCS location is approximately 3.5 miles offshore near the safety fairway (Figure 3-12). The sand there is an acceptable size (D50 = 0.28–0.33 mm), and the ambient water depths range from -45 to -60 feet. Estimated combined available volume is approximately 4.9 mcy. The site consists of 809 acres with cut elevations of -50 to -68 feet NAVD88 and cut thicknesses ranging between 4 and 18 feet. An obstruction is marked on the latest NOAA chart near the borrow site. The specified buffer, as indicated on the latest chart, is located off the shoal to the east approximately 150 feet from the borrow area.

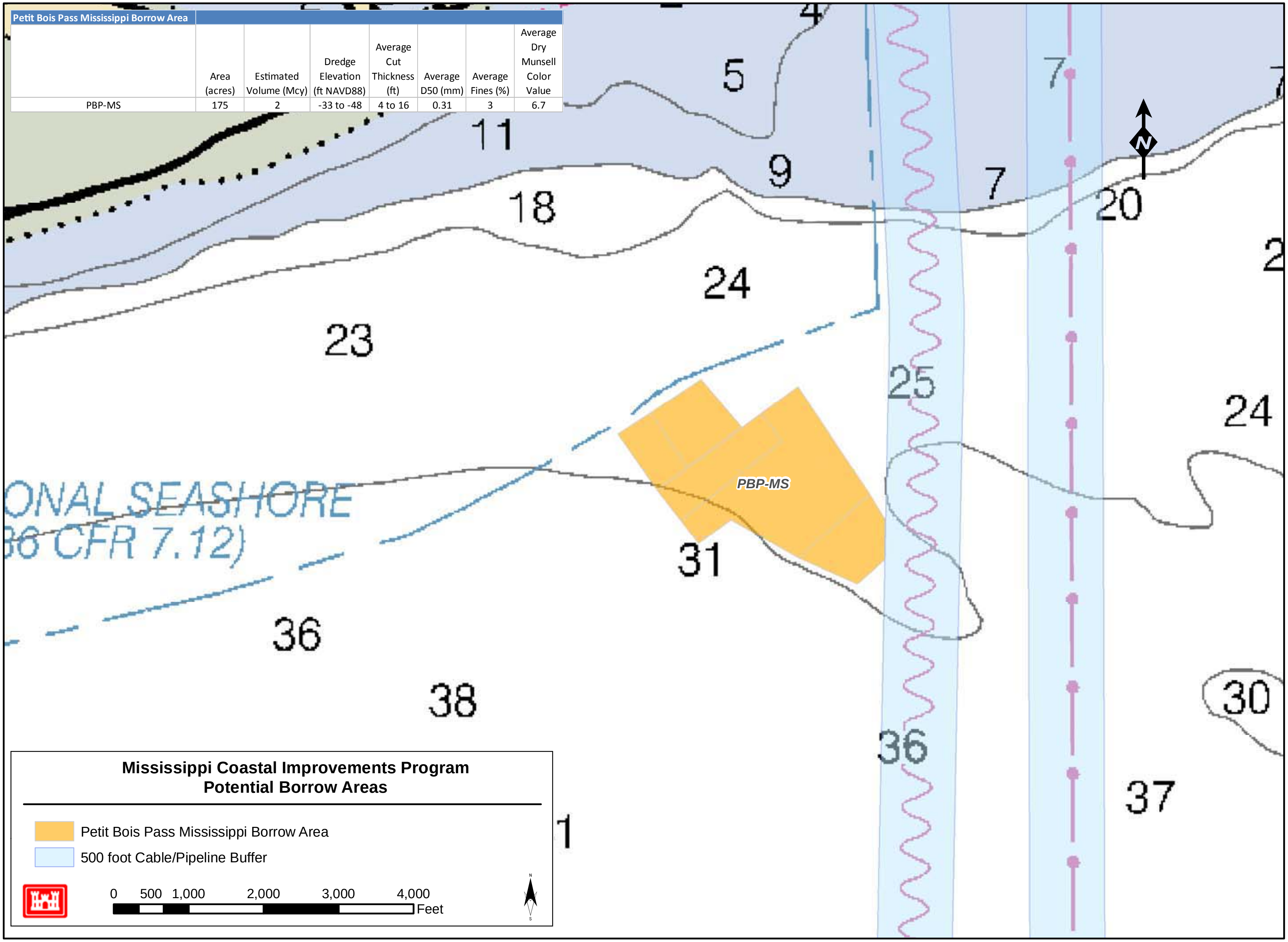
Figure 3-13 illustrates areas that are currently being investigated for the possibility of containing suitable borrow material. If additional borrow sites are selected as a result of these investigations, this information will be included in the final SEIS.

Table 3-4 summarizes potential borrow volumes from sites carried forward for further analysis, including the terrestrial and submerged habitat in each. DA-10/Sand Island is the only borrow site that includes both terrestrial and submerged habitat.

TABLE 3-4
Summary of Potential Borrow Volumes from Sites Carried Forward

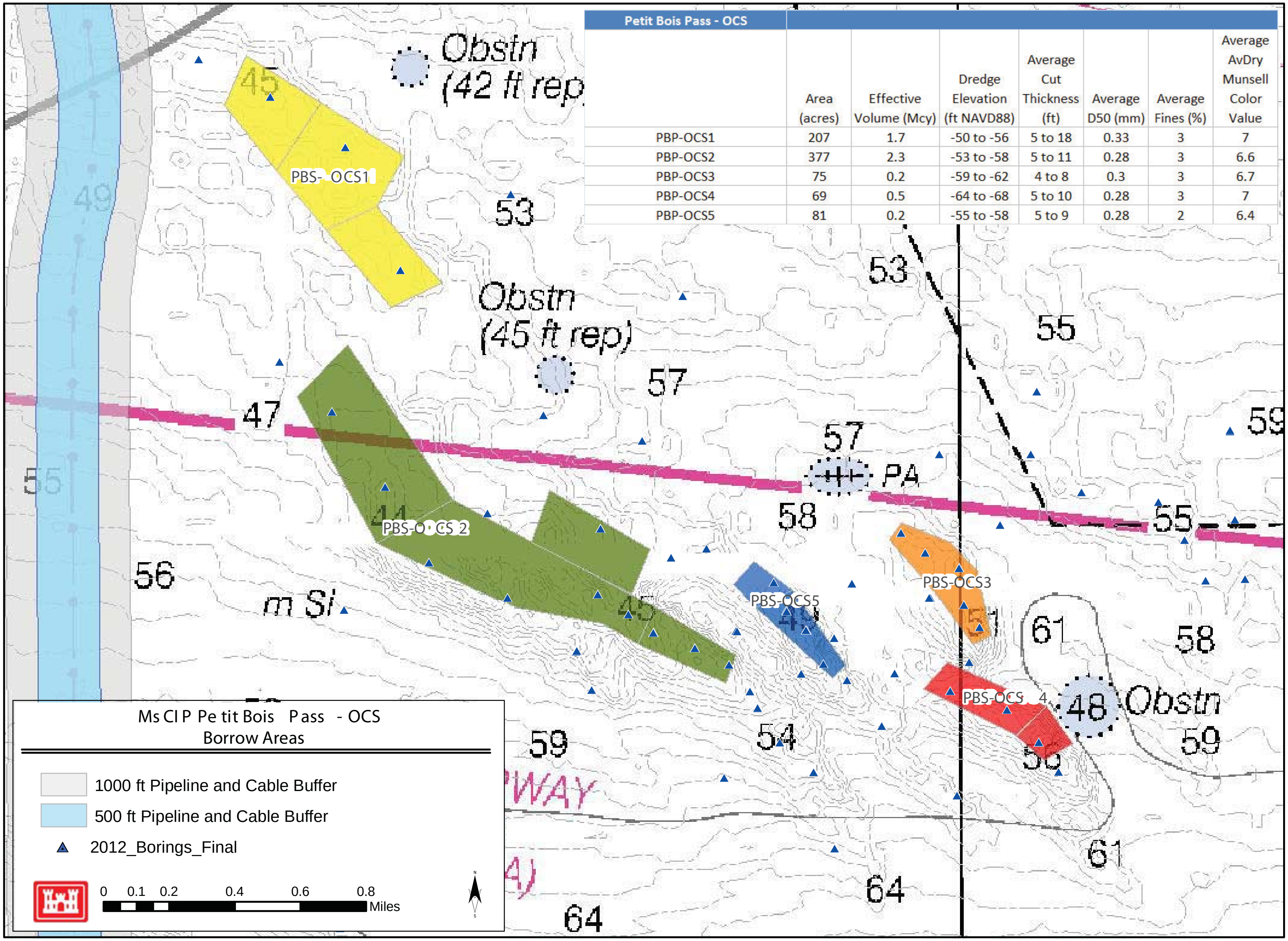
Borrow Areas	Terrestrial Habitat (ac.)	Submerged Habitat (ac.)	Total Acres	Estimated Borrow Volume (mcy)
Ship Island Borrow Area Option 3	0	83	83	1.2
DA-10/Sand Island Borrow Area Option 1	102	255	357	5.1
DA-10/Sand Island Borrow Area Option 2	58	246	304	3.7
Horn Island Pass	0	587	587	3.2
PBP-MS	0	175	175	2.0
PBP-AL East Option 2	0	885	885	13.1
PBP-AL West Option 2	0	380	380	2.9
PBP-OCS	0	809	809	4.9

Petit Bois Pass Mississippi Borrow Area	Area (acres)	Estimated Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average Dry Munsell Color Value
PBP-MS	175	2	-33 to -48	4 to 16	0.31	3	6.7



NOAA Chart 11373
Source Data: NOS surveys 1900 to 1989

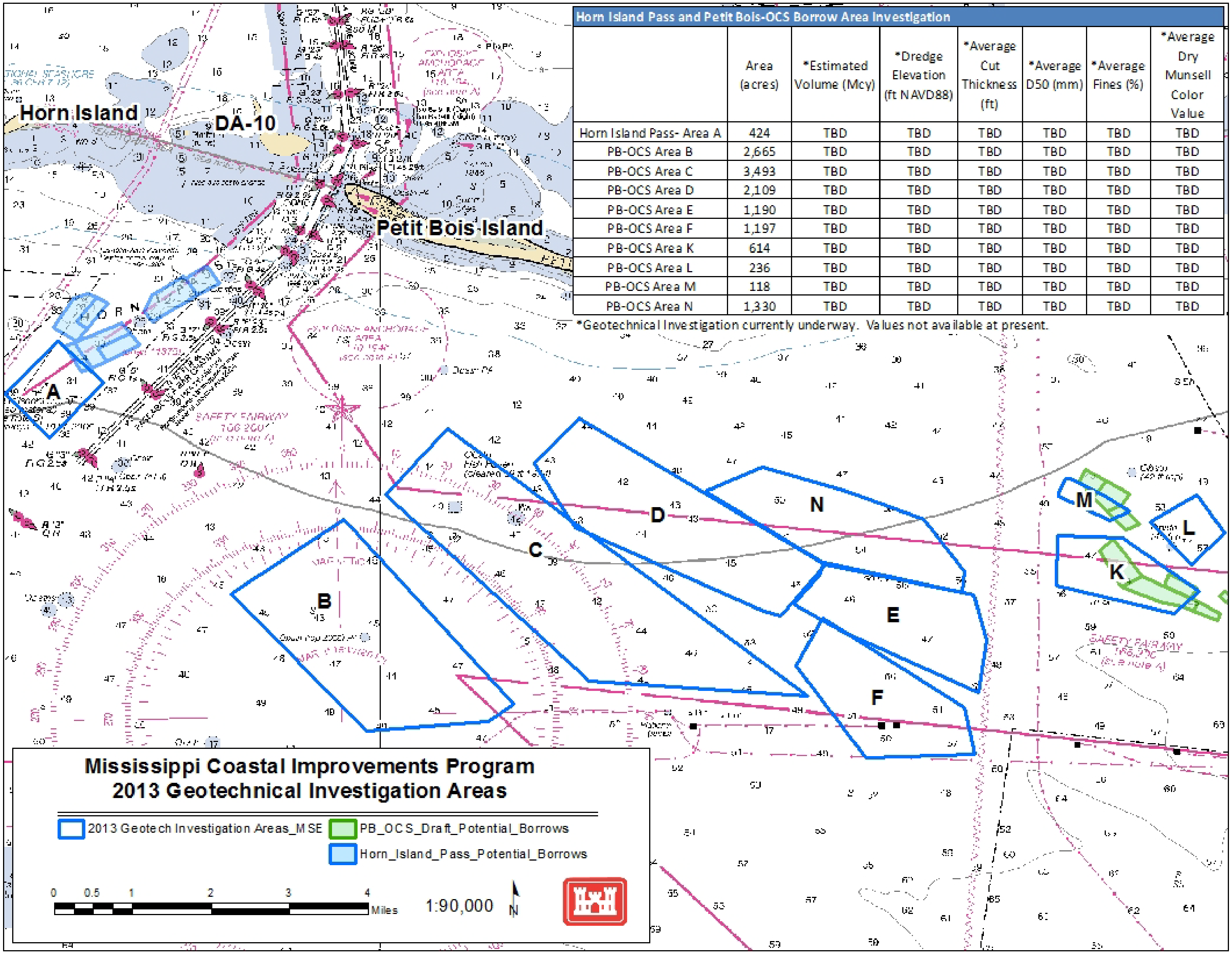
FIGURE 3-11
PETIT BOIS PASS-MISSISSIPPI BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



Petit Bois Pass - OCS	Area (acres)	Effective Volume (Mcy)	Dredge Elevation (ft NAVD88)	Average Cut Thickness (ft)	Average D50 (mm)	Average Fines (%)	Average AvDry Munsell Color Value
PBP-OCS1	207	1.7	-50 to -56	5 to 18	0.33	3	7
PBP-OCS2	377	2.3	-53 to -58	5 to 11	0.28	3	6.6
PBP-OCS3	75	0.2	-59 to -62	4 to 8	0.3	3	6.7
PBP-OCS4	69	0.5	-64 to -68	5 to 10	0.28	3	7
PBP-OCS5	81	0.2	-55 to -58	5 to 9	0.28	2	6.4

NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-12
PETIT BOIS PASS - OUTER CONTINENTAL SHELF BORROW AREA
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



Horn Island Pass and Petit Bois-OCS Borrow Area Investigation

	Area (acres)	*Estimated Volume (Mcy)	*Dredge Elevation (ft NAVD88)	*Average Cut Thickness (ft)	*Average D50 (mm)	*Average Fines (%)	*Average Dry Munsell Color Value
Horn Island Pass- Area A	424	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area B	2,665	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area C	3,493	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area D	2,109	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area E	1,190	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area F	1,197	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area K	614	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area L	236	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area M	118	TBD	TBD	TBD	TBD	TBD	TBD
PB-OCS Area N	1,330	TBD	TBD	TBD	TBD	TBD	TBD

*Geotechnical Investigation currently underway. Values not available at present.

NOAA Chart 11373
Source Data: NOS surveys 1940 to 2009

FIGURE 3-13
ADDITIONAL BORROW SITE INVESTIGATION AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

3.2.2 Sand Placement Evaluations

The recommended plan identified in the MsCIP PEIS included placement locations at Camille Cut and at the littoral zones at East Ship Island, Petit Bois Island, and Cat Island (Figure 3-1). Through further analyses (discussed below), littoral zone placements were eliminated at East Ship Island, Petit Bois Island, and Cat Island and direct placements were added along the southern shoreline of East Ship Island and eastern shoreline of Cat Island. In general, at East Ship Island and Petit Bois Island, a one-time direct placement of sand in the littoral zone would be at risk of being displaced by the dominant long-shore transport mechanism. Analyses indicate that sand should be placed on the southern shoreline of East Ship Island to ensure re-establishment of the barrier island. At Cat Island, analyses indicate that cross-shore transport mechanisms are not dominant, and that material should be placed on the eastern shoreline to maintain the island and prevent land losses due to erosion.

3.2.2.1 Desktop Analysis of Camille Cut Closure Options

A desktop analysis was conducted to provide relative comparisons between borrow sources for Camille Cut (Appendix L). The analysis was intended as a screening tool to narrow the options for further detailed engineering analysis and hydrodynamic and sediment transport modeling. The desktop analysis assumed the following:

- Historical processes, inferred from the sediment budget as detailed in Byrnes et al. (2012) (Appendix B), would continue through time.
- Preferable fill designs are those that maintain a critical width of 500 feet or greater for a period of 30 years. The 500-foot width represents the smallest island width that minimizes net loss of sand from the barrier island over periods from decades to centuries.
- Preferable borrow sources would have a D50 greater than 0.28 mm to increase the stability of the fill and maximize the life of the sediment within the island system.
- East Ship would continue to provide a source of sand for Camille Cut fill.

In general, results demonstrated that material placed in Camille Cut with a coarser median grain size would result in a more stable fill section with greater longevity. Also, a smaller footprint within Camille Cut with less volume could be constructed using coarser-grained material while still maintaining the critical width over a 30-year period, because finer-grained material erodes faster and, adjust further offshore therefore, a larger quantity is needed to achieve the same goal.

The desktop analysis did not include the potential effects of tropical storms, littoral zone placement, or offshore borrow sources. These were analyzed on a subset of selected designs in the hydrodynamic and sediment transport modeling work (Appendices C and D). The designs carried forward for further analysis based on results of the desktop assessment are described in the following sections. Appendix L contains the desktop analysis. Appendix D contains details of the predicted response of restoration designs to different synthetic storms.

3.2.2.2 Sediment Transport Modeling and Analysis

The original plan for restoration of the 3.5-mile-long Camille Cut (from the PEIS) consisted of placing approximately 13.5 mcy of sand obtained from an offshore borrow source at

St. Bernard Shoals. The newly formed island segment would be constructed as a low-profile berm connecting West Ship Island and East Ship Island.

The initial restoration template evaluated in this SEIS for Camille Cut and East Ship Island consisted of a 1,000-foot-wide equilibrated berm with a crest elevation of +8 feet NAVD88 for Camille Cut and a nearshore feeder berm with sand placed between elevations +1 foot and -15 feet for East Ship Island. The recommended alignment was based largely on the West and East Ship Island orientation and historical island shoreline locations dating back to the late 1800s. The total quantity for the design was 22 mcy and three different grain sizes were considered to evaluate the resilience of the restored design using different potential borrow sources. The median grain sizes were fine 0.2 mm sand, an intermediate grain size of 0.26 mm, and a relatively coarse 0.3-mm sand corresponding to the native sand. The equilibrated crest width of 1,000 feet was held constant for all modeling scenarios.

The modeling results for this configuration showed no island breaching during the 1-year and 10-year events for all three grain size scenarios. Sediment transport rates, however, for the fine sand were about 20 percent higher than for the coarse sand. For the 500-year event, breaching occurred with all three grain sizes, with sediment transport rates for the fine sand about 40 percent higher. The coarse-grained sand (0.3 mm) was considered the best option, because it resulted in significantly less sediment transport into the surrounding environment. Based on modeling results that indicated potential cross-shore losses into the Sound because of overwash for all events simulated, placement of sand at a higher elevation on East Ship Island was determined to be more beneficial to the downdrift island and to provide more immediate protection to the severely eroding southern shoreline of East Ship Island. Appendix D contains additional details of this analysis.

The initial restoration template for Camille Cut and East Ship Island was refined to evaluate severe storm impacts on a reduced template using coarser material (median grain size of 0.32 mm). The reduced template consists of a 700-foot-wide equilibrated berm with a crest elevation of +7 feet NAVD88 for Camille Cut and a 1,000-foot-wide equilibrated berm with a crest elevation of +6 feet along East Ship Island. The 700-foot-wide berm for Camille Cut was the minimum configuration determined from the desktop analysis to provide a critical width of approximately 500 feet over the 30-year design period. The design for East Ship Island was driven by the availability of a sufficient volume of sand (5–6 mcy) needed to supplement the littoral transport of the island for 20 to 30 years, based on the long-term sediment budget for the area. The elevation along Camille Cut was lowered by 1 foot to test the sensitivity of the design at a lower elevation, which is still consistent with natural higher elevations on the barrier island. The revised configuration resulted in increased sediment transport around the island compared to existing condition, as was the case for the original restoration template, with breaching also occurring for the 500-year event. Breaching did not occur for the 1- and 10-year events. The results of the revised configuration showed better protection for East Ship Island and transport pathways that feed the downdrift segments of the island. The revised configuration was carried forward, because it performed better than the original restoration template and resulted in a reduced project cost through the use of a lower quantity of sand for this fill area. Appendix D contains details of the revised configuration analysis.

3.2.2.3 Long-Term Morphological Modeling for Camille Cut and East Ship Island

The revised configuration was modeled further to determine long-term impacts of the proposed project on the surrounding environment. The intent was to assess the project's morphological response over a period of years for average and storm conditions. The following key questions were answered by the modeling results:

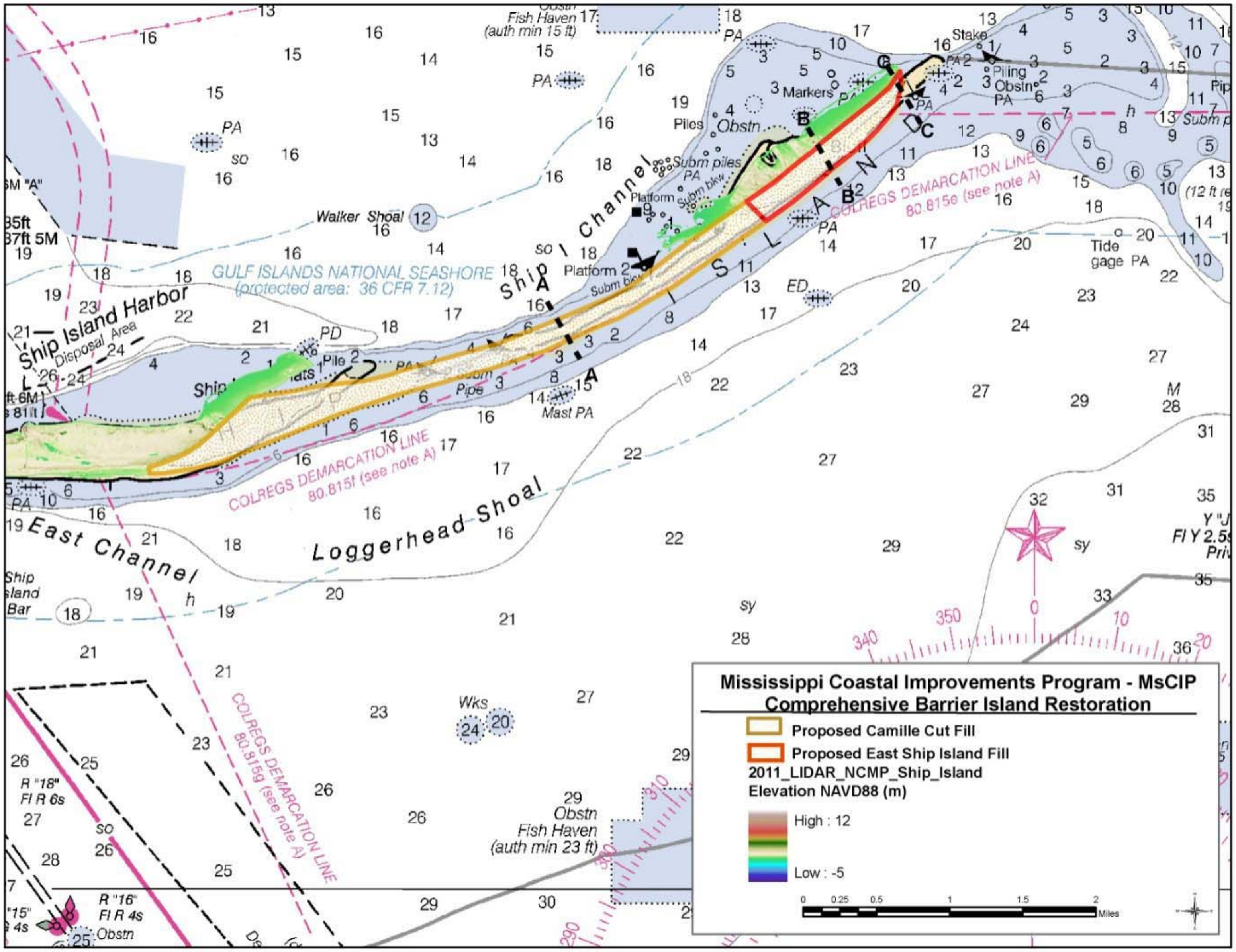
1. How will the closing of Camille Cut and the nearshore sand placement at the southeast end of Ship Island affect sediment transport?
2. Will sand extracted from borrow sites adversely affect erosion and deposition on the barrier islands?
3. How will the closing of Camille Cut and sand placement at the southeast end of Ship Island affect operation and maintenance of the Gulfport Federal Navigation project at Ship Island Pass?

The results of the analysis showed that sediment transport would increase around the island because more sand would be introduced into the system for movement. However, the effects are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass should be minor under average conditions. There could be an increase in sedimentation in the navigation channel during hurricane events. The larger hurricanes considered (Katrina, Georges) resulted in a 10–30 percent increase in sedimentation in the entrance channel. The smaller hurricanes resulted in a 5–10 percent increase. No negative impacts would be expected from the extraction of sand from the 1.2-mcy Ship Island borrow site. Appendix B contains further details of the long-term morphological modeling. The design that was developed from the results of the modeling efforts is described below.

3.2.2.4 Optimal Design for Restoration of Ship Island

The original plan consisted of placing 5 mcy of sand from an offshore borrow site at St. Bernard Shoals in the subaqueous littoral zone east of East Ship Island. This was based on an initial analysis of historical survey data sets and numerical modeling, as discussed in the MsCIP PEIS. Additional studies conducted in support of final design, including the update of the initial analysis, indicated that placement of sand in the littoral zone would not be the direct benefit needed for the eastern portion of Ship Island due to the dynamics of the shoal system within Dog Keys Pass. To ensure a more direct benefit to the islands, the littoral zone placement was eliminated in favor of options related to direct placement along the subaerial beach part of the littoral zone immediately adjacent to East Ship Island.

The final recommended design, described below, is based on the desktop analysis and subsequent hydrodynamic and morphological modeling. The constructed Camille Cut template would be approximately 1,100 feet wide (Figure 3-14). The fill would tie into the existing shoreline just below the frontal dune line at an elevation of +7 feet (NAVD88) with a 1V:12H (vertical:horizontal) slope to the mean high water level (MHWL) and a 1V:20H slope below it. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the East Ship Island placement, as described below.



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2012

FIGURE 3-14
PROPOSED RESTORATION AREAS AT CAMILLE CUT AND EAST SHIP ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

As constructed, the seaward slope of the profile would be steeper than the natural slope (from 1:50 to 1:100); however, based on professional experience, the construction profile is expected to adjust typically over a 12-month period to mimic the island's nearshore slopes. This would occur through the erosion of the upper profile and subsequent deposition near the toe of the fill until its equilibrium profile mimics the natural nearshore profile shape. The construction and equilibrium beach profiles would contain essentially equal volumes of sand; the volume eroded from the upper profile during the adjustment process would equal the volume deposited at the toe of the fill. The equilibrium design width would average approximately 700 feet. The tie-in points of the fill area at both ends would grade into existing contours without substantial breaks in elevation. The fill configuration would preserve the spits protruding northward from West and East Ship Islands at either end of Camille Cut.

Assuming an average water depth of about 5 feet in the existing breach, approximately 13.5 mcy of sand would be required to fill Camille Cut in this manner. Sand used to fill Camille Cut would come from a combination of offshore borrow areas (see Section 3.2.1), including Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island. Coarser sand from the Horn Island Pass, PBP-MS, PBP-AL, and PBP-OCS sites would be placed first as fill within Camille Cut and then capped with the finer sand from the Ship Island borrow area (1 mcy). The coarser sand would provide greater stability for the project, while the finer sand deposits would better facilitate the establishment of native dune vegetation. The direct placement of sand to fill Camille Cut would be a one-time event.

The newly created island segment would be planted as sand placement in Camille Cut progresses with native dune vegetation, including sea oats or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in groupings along all shorelines within the newly created beach. Once established, dune grasses would be expected to trap windblown sand, forming naturally shaped sand contours similar to those of other dunes on the Mississippi barrier islands.

The restoration of East Ship Island would consist of placing approximately 5.5 mcy of sand along the southern shoreline. In addition to restoring the southern shoreline, sand placed in that area would migrate with the littoral drift to support the overall replenishment of the system as identified in the sediment budget analysis and transport modeling. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1:20 slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom).

Sand used to restore East Ship Island would come from a combination of offshore borrow areas (see Section 3.2.1), including Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island. Placement of the material would be concurrent with the fill of Camille Cut.

The combined Camille Cut and East Ship Island equilibrated fill would encompass approximately 1,500 acres, of which 800 acres would be above the MHWL. The activities USACE is undertaking as part of the Comprehensive Barrier Island Restoration of West and East Ship Islands, including filling Camille Cut, restoring the southern shore of East Ship Island, and the proposed planting of native vegetation, are collectively a one-time event, as described in the MsCIP Comprehensive Plan and PEIS (USACE, 2009a). No future operations or maintenance activities would be conducted.

3.2.2.5 Analysis and Design for Restoration of Cat Island

Sand placement in the Cat Island littoral zone was conceptually identified in the MsCIP PEIS. Further investigation was recommended to define the exact placement location and quantity applicable for restoration of the eastern shoreface of the island. Restoration of Cat Island through direct placement was strongly supported in the public comments received on the PEIS, as it is generally believed that a robust Cat Island is a necessary element of risk reduction for the western Harrison and Hancock County mainland shorelines. The use of littoral placement as an indirect means of restoration was eliminated in favor of direct placement based on the comments and on extensive sediment budget analysis.

The restoration of Cat Island was developed through analyses of long-term sediment transport processes, the littoral sediment budget, shoreline change, sediment compatibility, and potential impacts due to the removal of material from identified borrow sources. To ensure replication of natural sediment pathways and minimization of potential adverse impacts, historical topographic surveys, bathymetric surveys, and dredging records over a period of record from 1846–2010 were compared to quantify past and present changes in the sand flux and the potential impact of dredging activities on transport quantities throughout the littoral system. The analysis indicated that littoral sand transported along Cat Island is reworked from the progradational beach ridge complex with little or no natural migration of sand across Ship Island Pass. This finding was further validated by hydrodynamic and sediment transport modeling (Appendix C). Therefore, it was determined that habitat restoration on Cat Island would benefit most from the direct placement of sand on the beach rather than from placing sand in the littoral zone. Placement directly on the beach at Cat Island is expected to reduce land loss of the island.

The recommended design for Cat Island involves direct placement of 2 mcy of sand on the eastern beach of the island. The design was largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. These conditions were determined to be the best conditions that would be feasible to implement, given the availability of sand for restoration and the anticipated project funding budget. The planning-level design for Cat Island is less robust than designs for other project components because of potential land ownership constraints identified during the design process. Upon identification of Cat Island restoration as part of the TSP, a more detailed design would be developed.

The planning-level construction template includes an average dune crest width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed crest width of about 250 feet at an elevation of +5 feet with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would provide area to restore the island habitats, thereby enhancing the island's ability to absorb energy from westward-propagating waves. The steeper construction profile is expected to adjust rapidly through erosion to mimic the milder natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages approximately 175–200 feet. The total equilibrated fill area encompasses approximately 305 acres.

Sand used in the restoration of Cat Island would come from a 282-acre sand deposit in an area about 2 miles long and 0.2 mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-15). The borrow site would be east of the placement area and outside the GUIS boundaries. Geophysical survey data indicate that extensive sand deposits are available in the area (Appendix A). The borrow site would be dredged to a depth of 3–5 feet to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation. The borrow area design is configured to prevent significant adverse impacts to the transport system, and use of this site would not affect or adversely modify critical habitat or threaten the continued existence of protected species.

3.2.2.6 Analysis of Littoral Placement of Future Dredged Material from the Pascagoula Federal Navigation Channel

The USACE would modify the management of dredged material from the Pascagoula Federal Navigation project to enhance the littoral transport of sand from the site westward along the island chain and to improve the navigational characteristics of the adjacent channel. This modification would involve combination of existing DA-10 littoral zone and reorientation of placement within this combined site. These two sites (DA-10 and the littoral zone) have been combined to allow for optimal movement of placed sediment. Figure 3-16 shows the existing area of littoral placement at DA-10, and Figure 3-17 shows the proposed area of littoral placement.

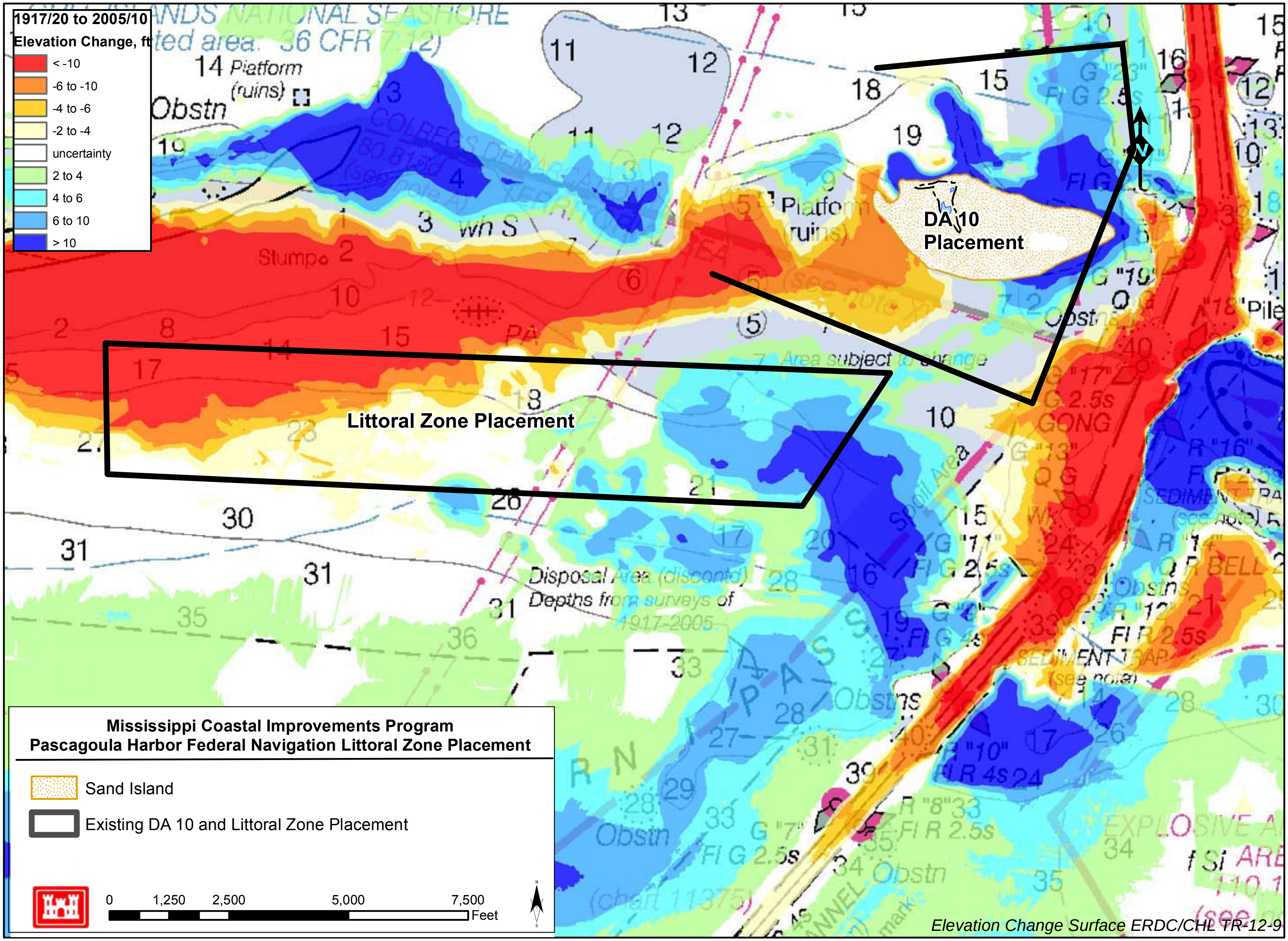
This component of the project includes revisions to the dredged material placement practices within the littoral zone at Horn Island. The intent of the revisions is to ensure that placement of dredged material within the littoral zone best replicates natural sediment pathways in the system and minimizes potential adverse impacts to the surrounding area while not increasing costs for operation and maintenance of the Pascagoula Federal Navigation Channel. The need for these revisions was identified through the analysis of long-term sediment transport processes, the littoral sediment budget, historical dredging records, and modeling of sediment transport potential. Historical topographic surveys, bathymetric surveys, and dredging records over a period of record from 1846–2010 were compared to quantify past and present changes in the sand flux and the potential impact of dredging activities on transport quantities throughout the littoral system. Results of the sediment budget analysis showed that approximately 6.3 mcy (68,000 cy/yr) of dredged material had been removed from and placed offshore of the active littoral zone since 1917. In addition, another 6.8 mcy (73,000 cy/yr) had been placed within DA-10/Sand Island (Appendix B) during this same period. Although the intent of placing dredged material from Horn Island Pass at DA-10 was to put the material within the downdrift littoral system to continue to supply sediment to the barrier islands, the analysis indicated that the average transport rates are extremely low in this area because Sand Island is too far north on the shoal.

In addition, disposal of material within DA-10/Sand Island has resulted in a reduction in conveyance area through the pass, causing increased velocities and scour. This has resulted in scour at depths as great as 20 feet deeper than authorized (Appendix B).

It is recommended that suitable sandy material dredged from the Horn Island Pass part of the Pascagoula Federal Navigation Channel be placed in the combined DA-10/littoral zone site along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Appendix F). This area is preferred from both a sediment transport potential and an operational standpoint to minimize unnecessary pumping distances.

FIGURE 3-15
PROPOSED RESTORATION AREA AT CAT ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV Restoration_Cat 4/15/13 lk



NOAA Chart 11373
Source Data: NOS surveys 1970 to 2009

FIGURE 3-16
EXISTING DA-10 LITTORAL ZONE PLACEMENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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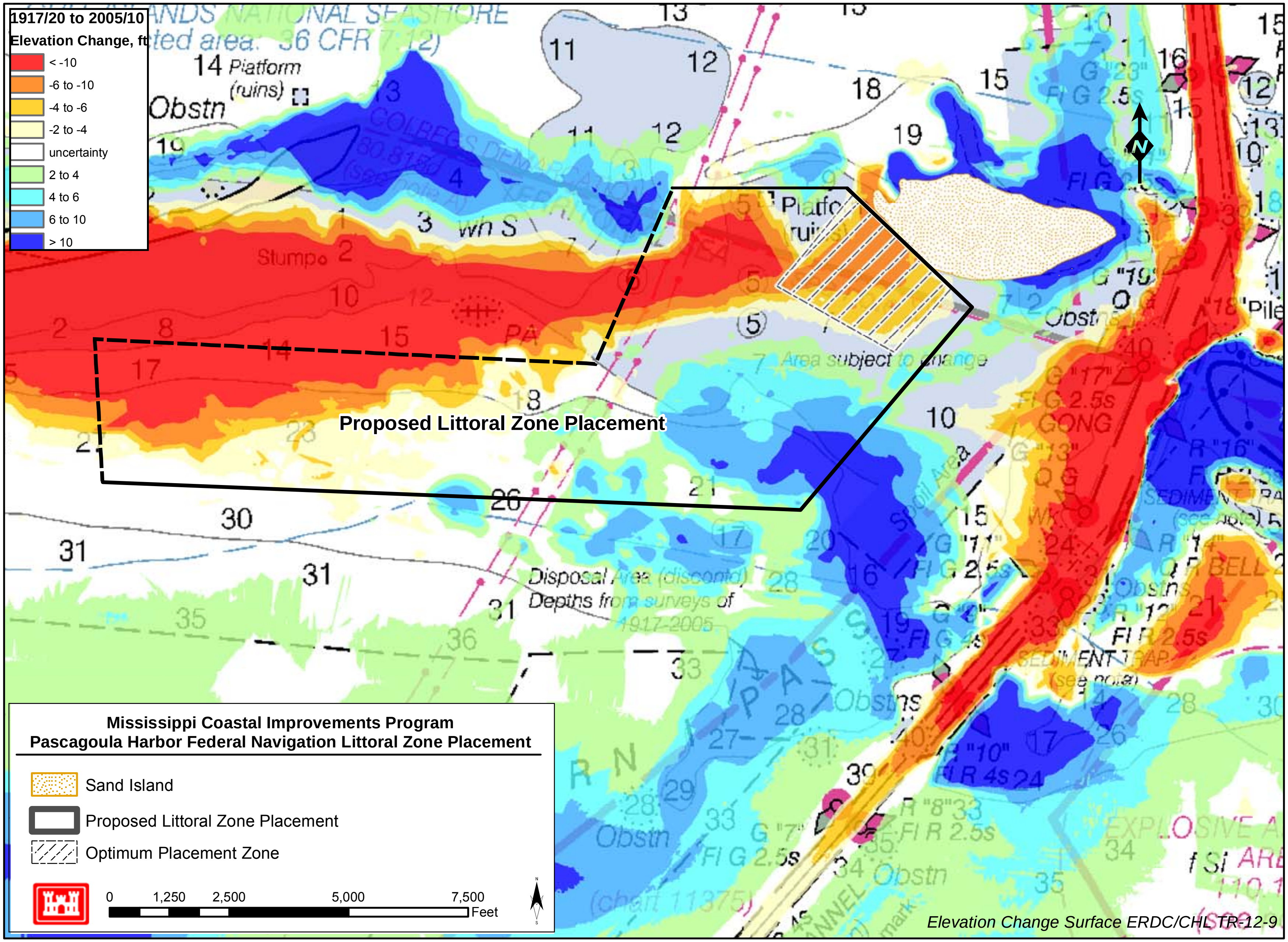


NOAA Chart 11373
Source Data: NOS surveys 1970 to 2009

FIGURE 3-17
PROPOSED DA-10 LITTORAL ZONE PLACEMENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

3.2.3 Construction Methodology Evaluation

3.2.3.1 Dredging and Construction Equipment

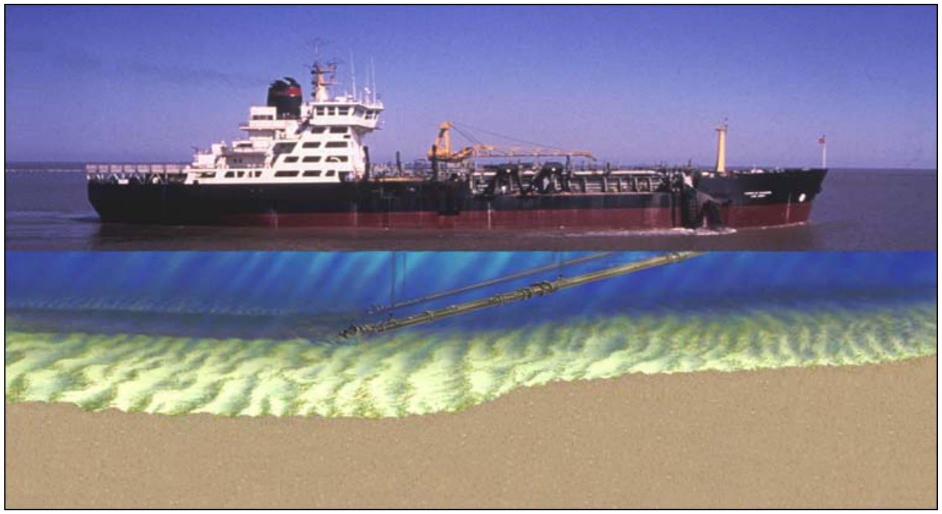
The dredging equipment that would be used for removal and placement depends primarily on the volume of material to be collected, the depth of the borrow material, and the depth of the water over the site. Most dredging would be performed using hydraulic dredges (Figure 3-18). Hydraulic dredges work by excavating a mixture of dredged material and water from the bottom. During operation, the amount of water pulled in with the material would be controlled to make a workable mixture. Water pumped would be discharged with the sand at the point of placement. A pipeline dredge would be used to excavate sand through an intake pipe, and then push it out of a discharge pipeline directly into the placement site. Because pipeline dredges pump directly to the placement site, they operate continuously and are cost-efficient. Most pipeline dredges have a cutterhead on the suction end. A cutterhead is a mechanical device equipped with rotating blades or teeth to break up or loosen the bottom material so that it can be sucked through the dredge. Pipeline dredges are mounted on barges and are not usually self-powered, but are towed to the dredging site and secured in place by spuds (anchor pilings). Cutterhead pipeline dredges work best in large protected areas with deep shoals, where the cutterhead is buried in the bottom.

Hopper dredges are ships with large hoppers, or containment areas, inside (Figure 3-18). These dredges are fitted with powerful pumps. During operation, the dredge suctions material from the channel bottom through long intake pipes, called drag arms, and stores it in the hoppers. The water portion of the slurry is drained from the material and is discharged from the vessel during operations. When the hopper is full, dredging stops and the ship travels to the placement site for discharge. Hopper dredges are well-suited to dredging heavy sands. They can maintain operations in relatively rough seas and because they are mobile, can be used in high traffic areas. However, because of their size, they cannot be used in confined or shallow areas. Hopper dredges can move quickly to disposal sites under their own power, but since the dredging stops during transit to and from the disposal area, the operation loses efficiency if the haul distance is great (USACE, 2011a).

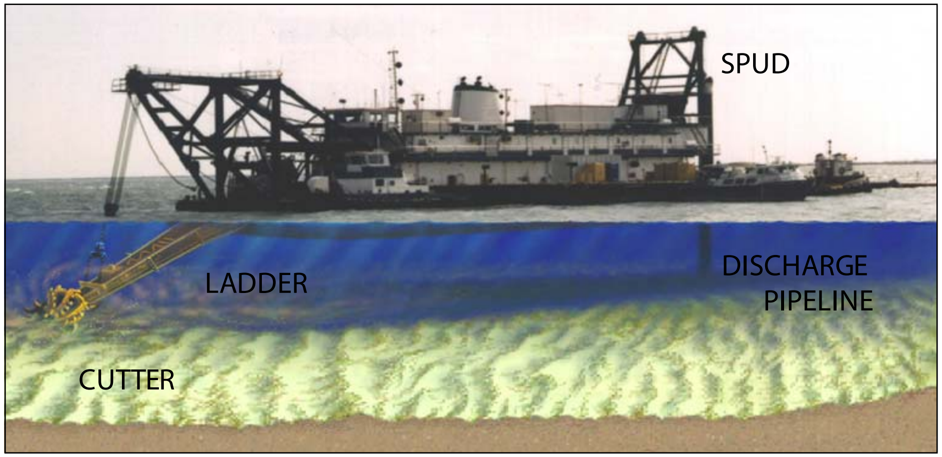
Additional dredging and placement could be conducted using bucket/mechanical dredges. The dredges remove material by scooping it from the bottom and then placing it onto a waiting barge or into a designated area. Mechanical dredges can work in tightly confined areas and are best at moving consolidated, or hard-packed, materials. The dredges typically are mounted on a large barge, towed to the dredged site, and secured in place by anchors or spuds.

Usually disposal barges, called dump scows, are used in conjunction with a mechanical dredge to move dredged materials. If numerous barges are used, work can proceed continuously, only interrupted by changing dump scows or moving the dredge (USACE, 2011a). For this project, only material from DA-10/Sand Island (if used) would be loaded into scows and transported to the placement location.

Hopper Dredge



Hydraulic Cutterhead Pipeline Dredge



Pipeline Dredge Discharge

Bucket/mechanical Dredge

FIGURE 3-18
DREDGING DEVICES FOR THE MOVEMENT AND PLACEMENT OF SAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Other construction equipment used would vary based on site conditions and specific project needs, but would include sediment transport equipment, retaining structures, heavy machinery, and a variety of support equipment. Sediment transport equipment could include several types of conveyances, such as scows, crane barges, and jack-up barges, pipelines (submerged, floating, and land), and booster pumps. Heavy machinery would be used to move sand and facilitate construction. The equipment could include bull-dozers, front-end loaders, track-hoes, marshbuggy trackhoes, and backhoes. Various support equipment also would be used, such as crew and work boats, trucks, trailers, construction trailers, all-terrain vehicles, and floating docks with pilings to facilitate loading and unloading of personnel and equipment.

Along with the dredges, this equipment could be staged offshore and outside the restoration area during use. At Ship Island, the area between the -30-foot contour, the GIWW, Gulfport Navigation Channel, and Dog Keys Pass (Figure 3-19) could be used to stage or anchor equipment before or during use. Equipment also would be staged onshore. Heavy machinery, vehicles, sediment retaining structures, and other construction equipment could be parked or staged before and during use.

3.2.3.2 Construction Mixing Options

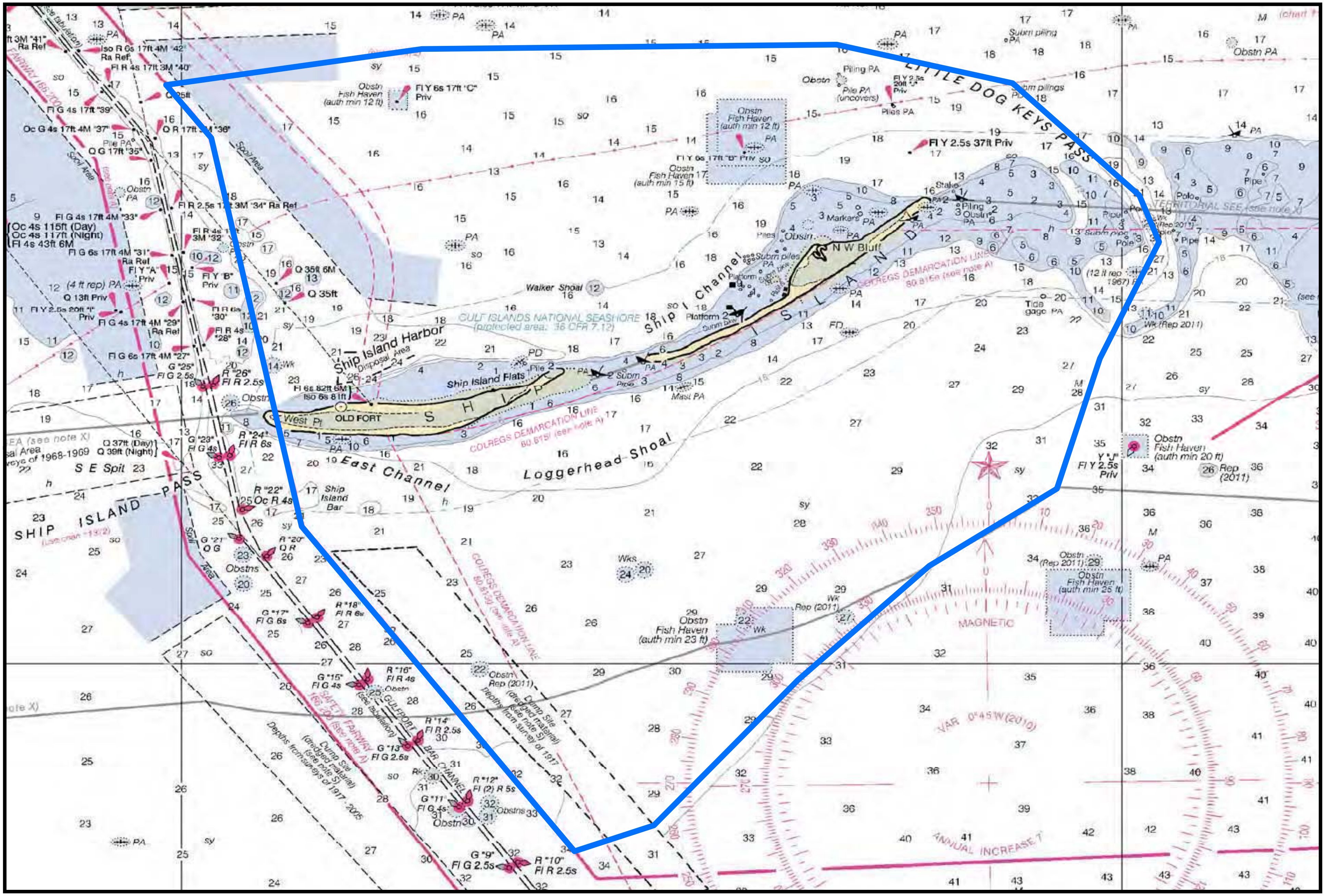
Four options for mixing sand dredged from separate borrow areas were considered for filling Camille Cut. The options take into account the need for compatible sand on Ship Island to resist erosion while maximizing the use of finer-grained sources. No mixing options were considered for Cat Island. For each option described below, material would be dredged, hauled to Ship Island, and pumped off directly to the southern shoreline of East Ship Island. The following construction options were evaluated for placing sand in Camille Cut.

Offshore Mixing

Offshore mixing would consist of dredging sand from the Petit Bois Pass borrow area and placing it on the sand in the Ship Island borrow area. Material from the Petit Bois Pass site would likely have to be pumped off onto the Ship Island borrow area because the water surrounding the borrow site is too shallow for most hopper dredges to access and bottom dump. Once the material from the Petit Bois Pass site is placed atop the Ship Island borrow area, a cutterhead dredge would be used to dredge the layered material (coarse-grained material from Petit Bois Pass on the fine-grained material from the Ship Island borrow area) and place it in Camille Cut. Mixing would be achieved during this phase of the dredging/ placement process. Approximately 8 mcy of sand from each borrow site (16 mcy total) would be used.

Onsite Mixing

The difference in the onsite mixing approach is that the material from the Petit Bois Pass site would be disposed of in an area south of the Ship Island borrow area (rather than on top of it) where the water depths would allow all hopper dredges to bottom dump the material (instead of pumping off). Two cutterhead dredges would then be used to achieve mixing. One dredge would work in the Ship Island borrow area and one in the area where the Petit Bois Pass material was deposited. The dredge discharge lines would be combined to achieve a mixed slurry of dredged material at the placement site. About 8 mcy of sand from each of the borrow sites (16 mcy total) would be used.



Potential Temporary Construction Disturbance Area

NOAA Chart 11375
Source Data: NOS surveys 1970 to 2012

FIGURE 3-19
POTENTIAL CONSTRUCTION STAGING AREA FOR RESTORATION AT CAMILLE CUT AND EAST SHIP ISLAND
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Finer-Grained Core

Under the finer-grained core option, 2.5 mcy of finer-grained sand from the Ship Island borrow area would be dredged and pumped to Camille Cut to an elevation of +5 feet NAVD88, with widths ranging from approximately 150 feet on the eastern end to upwards of 300 feet on the western end. The core would then be covered with approximately 13.5 mcy of coarse-grained sand from the Petit Bois Pass borrow area. Because of differences in production rates of equipment and pump/haul distances, which would increase the exposure time, the finer core fill section would require a temporary containment structure (such as biodegradable geotubes or sheet pile walls, if approved by NPS) to reduce the risk associated with exposure during construction.

Capping

Under the capping option, coarser-grained sand dredged from the Petit Bois Pass borrow area and finer-grained sand dredged from the Ship Island borrow area would be pumped separately into Camille Cut. Approximately 15 mcy of the coarser-grained sand from the Petit Bois Pass site would be placed first to provide a stable berm. Then 1 mcy of finer-grained sand from the Ship Island borrow site would then be placed as a cap to provide a more suitable substrate for vegetation. Of the options identified, capping was evaluated as the optimal for dune planting and subsequent re-colonization.

3.2.3.3 Construction Phasing

The restoration work at Ship Island, including filling of Camille Cut and direct placement on East Ship Island shoreline, would be conducted in five phases:

- Phase 1 would consist of the construction of an initial berm across Camille Cut. The berm would have a crest width of about 500 feet and a top elevation of +5 feet NAVD88. The sand for Phase 1 (7 mcy) likely would be dredged from the PBP–OCS and Horn Island Pass areas, hauled 20–35 miles, and placed directly in Camille Cut. Work would take about 1 year to complete. Temporary features, such as sheet pile walls and biodegradable geotubes, if approved by NPS, may be used during Phase 1 to minimize the potential for sand losses by rapidly blocking flow through the cut. These features would be removed or allowed to naturally degrade after the work is complete.

- Phase 2 would consist of restoring the southern shoreline of East Ship Island (Figure 3-14) The restoration berm would have a constructed crest width of about 1,200 feet and a top elevation of +6 feet NAVD88. Sand for Phase 2 (5.5 mcy) would be dredged from a combination of Horn Island Pass and Petit Bois Pass (Alabama, Mississippi, and OCS). The sand would be hauled 25–38 miles and placed along the southern shoreline of East Ship Island. This phase is estimated to begin about 6 months after the commencement of Phase 1 and would take about 6 months to complete.

- Phase 3 would consist of placing the remaining sand from the Horn Island and/or Petit Bois Pass (Alabama, Mississippi, and OCS) areas in Camille Cut (5.5 mcy). The Camille Cut berm, after completion of Phase 3, would be built to a crest width of about 1,100 feet with a top elevation of +7 feet NAVD88. Part of the berm (upper-center) would be left void and would not be completely filled until Phase 4. Work under Phase 3 would begin immediately upon completion of Phase 1 and is estimated to take about 1 year to complete.

- Phase 4 would commence after the completion of Phase 3 and would consist of placing approximately 1 mcy of sand in the unfilled area of the upper-center part of the Camille Cut berm. The sand for Phase 4 would be dredged from the Ship Island borrow area and the work is estimated to take about 3 months to complete. Because of its finer grain size, the sand from the Ship Island borrow area would be used as a cap on the Camille Cut fill section to facilitate establishment of beach vegetation.
- Phase 5 would consist of planting the Camille Cut restoration berm with native dune vegetation. The work would begin upon completion of Phase 4 and take about 1 year to complete.

Restoration work at Cat Island would be conducted in one phase. The proximity of the borrow area to the island's eastern shoreline in relatively shallow water would allow the rapid placement of sand on the beach likely using a pipeline dredge. The material would be pumped onto the beach and shaped using land-based equipment. Following placement, the area would be vegetated with native grasses. Restoration would occur over approximately 6 months.

3.3 Summary of Alternatives Eliminated

The MsCIP PEIS of June 2009 evaluated a full range of barrier island ecosystem restoration alternatives, from very limited restoration of East Ship Island and West Ship Island to massive restoration of the islands' historical dimensions (USACE, 2009a). The ROD for the MsCIP PEIS recommended a comprehensive restoration plan that combined two of the alternatives. P.L. 111-32, enacted June 24, 2009, authorized and funded the recommended restoration plan for construction to restore historical levels of storm damage risk reduction to the Mississippi Gulf Coast. Thus, alternatives that were evaluated and rejected under the MsCIP PEIS are not carried forward for analysis.

Alternatives considered in this SEIS are tiered from the MsCIP PEIS (40 C.F.R. 1508.28). They include site-specific borrow areas, sand placement areas, and construction options for implementing the authorized project.

3.3.1 Borrow Material Sites Not Carried Forward

As detailed in Section 3.2.1.2, the St. Bernard Shoals, Gulfport Channel, Mississippi Sound, Ship Island Pass, Dog Keys Pass, and Lower Tombigbee River Upland disposal sites were identified as not feasible based on additional available information or detailed geophysical survey and associated boring samples. The following is the rationale for eliminating them:

- **St. Bernard Shoals—**Sand at this site is too dark gray and fine-grained (0.12–0.16 mm). Use of this site would not be cost-effective because of the distance from placement areas. The site is crossed by numerous pipelines that would complicate the dredging operation.
- **Gulfport Channel—**Since identification of this site, it has already been used as a borrow source for the West Ship Island north shore restoration (USACE, 2010b). Remaining sediments are unsuitable because of high silt and clay content and limited volumes of available sand.

- **Mississippi Sound—**Sand deposits at this site are mixed with areas of silt and clay overburden. The sand is finer than desired, with grain sizes ranging from 0.16–0.21 mm. The site is in designated critical habitat for Gulf sturgeon.
- **Ship Island Pass—**Upon investigation, sand deposits at this site were not as large as expected and contained 8–20 feet of muddy overburden. Most of the sand is finer than desired, with grain sizes ranging from 0.13–0.19 mm. The site is located in designated critical habitat for Gulf sturgeon.
- **Dog Keys Pass—**Most of the site is within GUIS boundaries, adjacent to and within the active tidal inlets that provide sediment to the barrier island system.
- **Lower Tombigbee River Upland Sites—**Particles at this site are coated with iron oxide and therefore have a reddish pink hue. Use of upland river sites would involve high costs associated with required haul distances (approximately 78 miles for the Sunflower disposal area and 92 miles for the Lower Princess disposal area, from the mouth of the Mobile River) and logistical difficulties in transporting the material to the placement locations.

3.3.2 Sand Placement Options Not Carried Forward

Three sand placement locations, as identified in the PEIS, were evaluated but not carried forward: East Ship Island littoral zone, Petit Bois Island littoral zone, and Cat Island littoral zone. As discussed in Section 3.2.2, the results of additional sediment transport modeling and evaluations determined that better replenishment of Ship and Cat Islands would occur from placement of sand on and immediately adjacent to East Ship Island and Cat Island rather than within the littoral zone. In addition, sediment budget analysis determined that there was sufficient material in the littoral zone of Petit Bois Island to support the island maintenance process (Appendix B). Because placement was not deemed necessary to maintain the island, this placement location was eliminated from further evaluation.

Three construction mixing options were considered but not carried forward. The offshore mixing and onsite mixing construction options were eliminated from consideration. They were less cost-effective than the capping option because of the need to handle the material multiple times. The finer-grained core construction option was eliminated even though its cost was comparable to that of the capping option, because it increased the risk of reducing the longer-term stability of the restored Camille Cut and posed significant construction challenges to contain the finer-grained material.

3.4 Alternatives Considered

3.4.1 No-Action

The No-Action Alternative represents without-project conditions that would occur in the project area without comprehensive restoration of the Mississippi barrier islands. The MsCIP PEIS (USACE, 2009a), from which this SEIS is tiered, describes future without-project conditions and evaluates the environmental effects of the No-Action Alternative. The No-Action Alternative serves as the baseline against which potential environmental impacts and benefits associated with site-specific implementation of barrier island restoration are compared.

Under the No-Action Alternative, erosion of the barrier islands would continue, increasing salinity of Mississippi Sound, and continuing degradation and loss of estuarine habitats and productive fisheries (USACE, 2009a). Net land loss and morphological changes would continue along the barrier islands into the future, primarily as a result of storms. Historical analysis of barrier island change by Morton (2008) and recent analysis by Byrnes et al. (2012) indicate that East Ship Island would continue to narrow and lose land area under the No-Action alternative. Sand transport from East Ship Island would be depleted in a matter of decades, as storm and other normal transport processes reduce the island to a shoal. Dog Keys Pass would become wider as East Ship Island evolves to a shoal, and natural sediment bypassing to West Ship Island would be greatly diminished. Cat Island would continue to lose land area from persistent erosion due to increased exposure to southeast waves from the Gulf.

Loss of coastal ecotone habitat would continue. Barrier islands and beaches along eroding margins of the islands would transition to open-water habitat. These changes would alter and reduce the integrity of existing beach and nearshore habitats for use by communities of terrestrial and benthic invertebrates, fish, wetland plants, submerged aquatic vegetation (SAV), marine mammals, and migratory and coastal birds (USACE, 2009a). Beach and littoral habitats for threatened and endangered species, such as Gulf sturgeon, sea turtles, and piping plover, would also diminish. Continuing loss of the barrier islands would alter water quality in Mississippi Sound as a result of increasing salinity and would threaten commercial and recreational fishing as well as essential fish and shellfish habitats for estuarine species. In addition, unprotected cultural resource sites along eroding shorelines of the barrier islands could be lost.

The structural integrity and efficacy of the barrier islands as a first line of defense of mainland habitats would continue to diminish, reducing the resilience of the coast against damage from future storms. These changes would threaten the estuarine ecosystem of Mississippi Sound and expose the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms.

As documented in the MsCIP PEIS (USACE, 2009a), the No-Action Alternative would fail to address the need for comprehensive improvements in the coastal area of Mississippi in the interest of hurricane and storm damage reduction, prevention of saltwater intrusion, preservation of fish and wildlife, prevention of erosion, and other related water resource purposes. Although the No-Action Alternative was determined not to meet the purpose of and need for barrier island restoration, it is considered herein to meet the requirements of NEPA and for use in Section 5 as the baseline for evaluating the effects of the TSP.

3.4.2 Tentatively Selected Plan

The only component of the action alternatives that varies from the TSP is the potential combination of borrow sites. All action alternatives carried forward include the following components:

- Restoration of Ship Island, including Sand Placement in Camille Cut and Replenishment of East Ship Island
- Beach-front and Dune Placement of Sand Along Cat Island
- Management of Maintenance Dredged Material from Pascagoula Ship Channel

The text below provides details on the three common components of the action alternatives.

3.4.2.1 Ship Island Restoration

The restoration of Ship Island includes closing Camille Cut, restoring the shoreline of the current East Ship Island, and using sand from five borrow areas (Borrow Site Option 4). Section 3.2.2.4 summarizes the detailed design. Restoration would be accomplished in 5 phases over a 2.5-year period, as described in Section 3.2.3.3.

Direct Sand Placement in Camille Cut

To restore East Ship Island and West Ship Island to a single elongated barrier island, the 3.5-mile-long Camille Cut would be filled with approximately 13.5 mcy of sand. Sand used to fill Camille Cut would come from a combination of borrow sites described below. Sand from potential borrow sites would likely be dredged with a hopper dredge and/or cutterhead dredge, loaded into scows, and hauled/pumped to the placement site.

The newly formed island segment would be constructed as a low-level dune system connecting West Ship Island and East Ship Island (Figure 3-20). The constructed Camille Cut template would be approximately 1,100 feet wide. The fill would tie into the island shoreline just below the frontal dune line at an elevation of +7 feet NAVD88 with a 1V:12H slope to the MHWL and a 1V:20H slope below the MHWL. The fill at its western and eastern ends would tie into the existing berm along the eastern end of West Ship Island and transition into the East Ship Island placement. Sand from potential borrow sites would likely be dredged with a hopper dredge, hauled, and then pumped directly onto the site. The direct placement of sand to fill Camille Cut would be a one-time event.

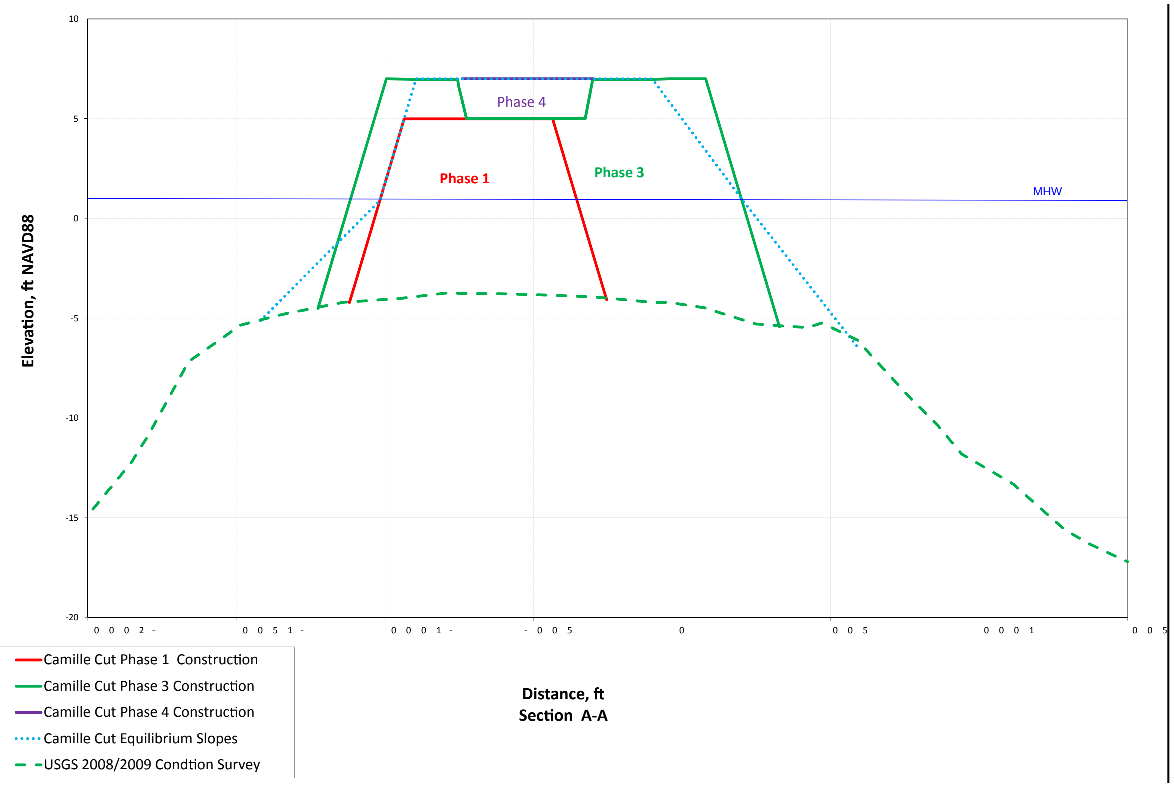
As sand placement in Camille Cut progresses, the newly created island segment would be planted with native dune vegetation, including sea oats and/or other grasses and forbs, to restore stable dune habitat. The planting would include dune grasses in groupings along all shorelines within the newly created beach.

Replenishment of East Ship Island

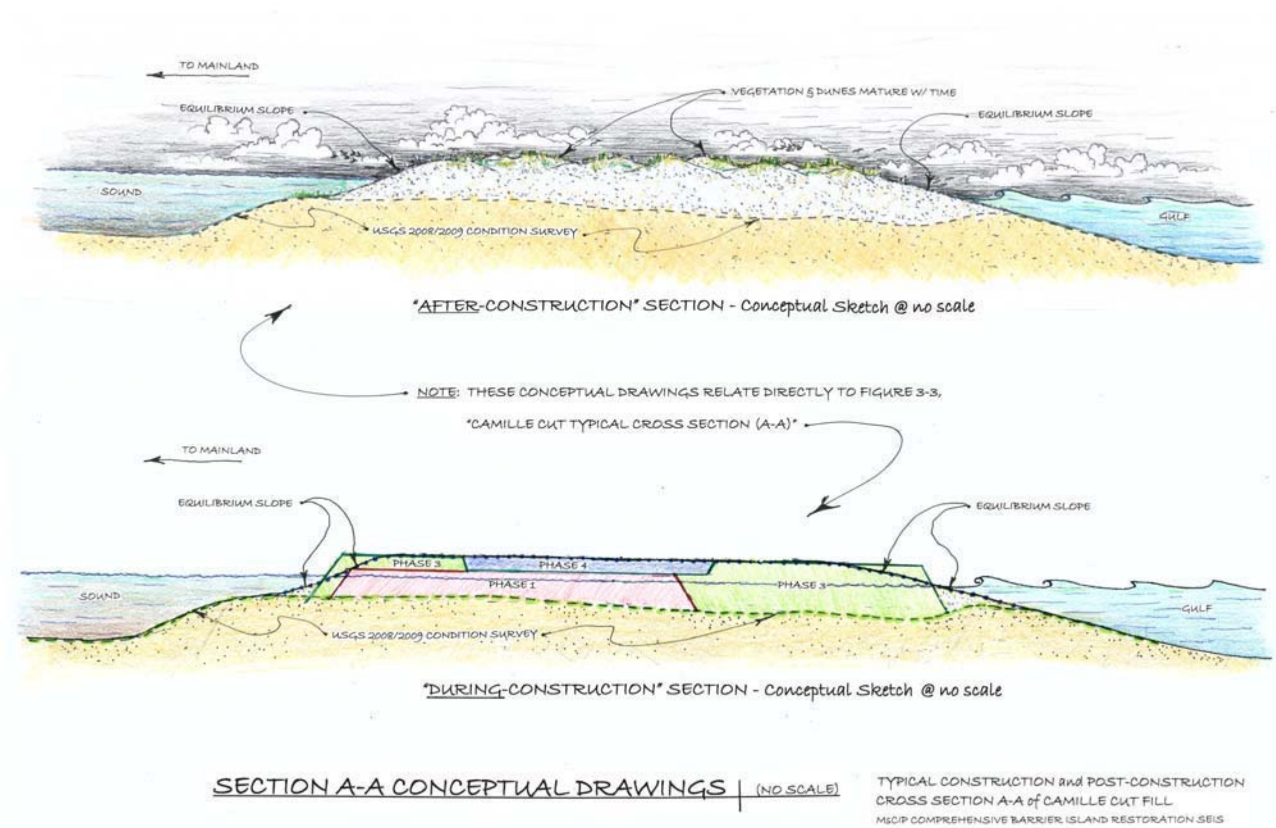
Restoration of East Ship Island would consist of placing approximately 5.5 mcy of sand along the southern shoreline. Placement of sand in this area would add material to the littoral system of Ship Island, which would support the overall replenishment of the system as identified in the sediment budget analysis and sediment transport modeling. The construction template for the restored southern shoreline would consist of an average berm crest width of approximately 1,200 feet at an elevation of +6 feet NAVD88 with a 1V:12H to 1V:20H slope from the seaward edge of the berm to the toe of the fill (intersection with the existing bottom) (Figures 3-21 and 3-22).

Sand used to restore East Ship Island would come from a combination of borrow sites. Sand from potential borrow sites would likely be dredged with a hopper dredge or cutterhead dredge, loaded into scows, and hauled/pumped to the placement site. Placement of the material would be concurrent with the fill of Camille Cut.

The combined Camille Cut and East Ship Island equilibrated fill would encompass 1,500 acres, of which 800 acres would be above the MHWL. The placement of sand would be a one-time event.

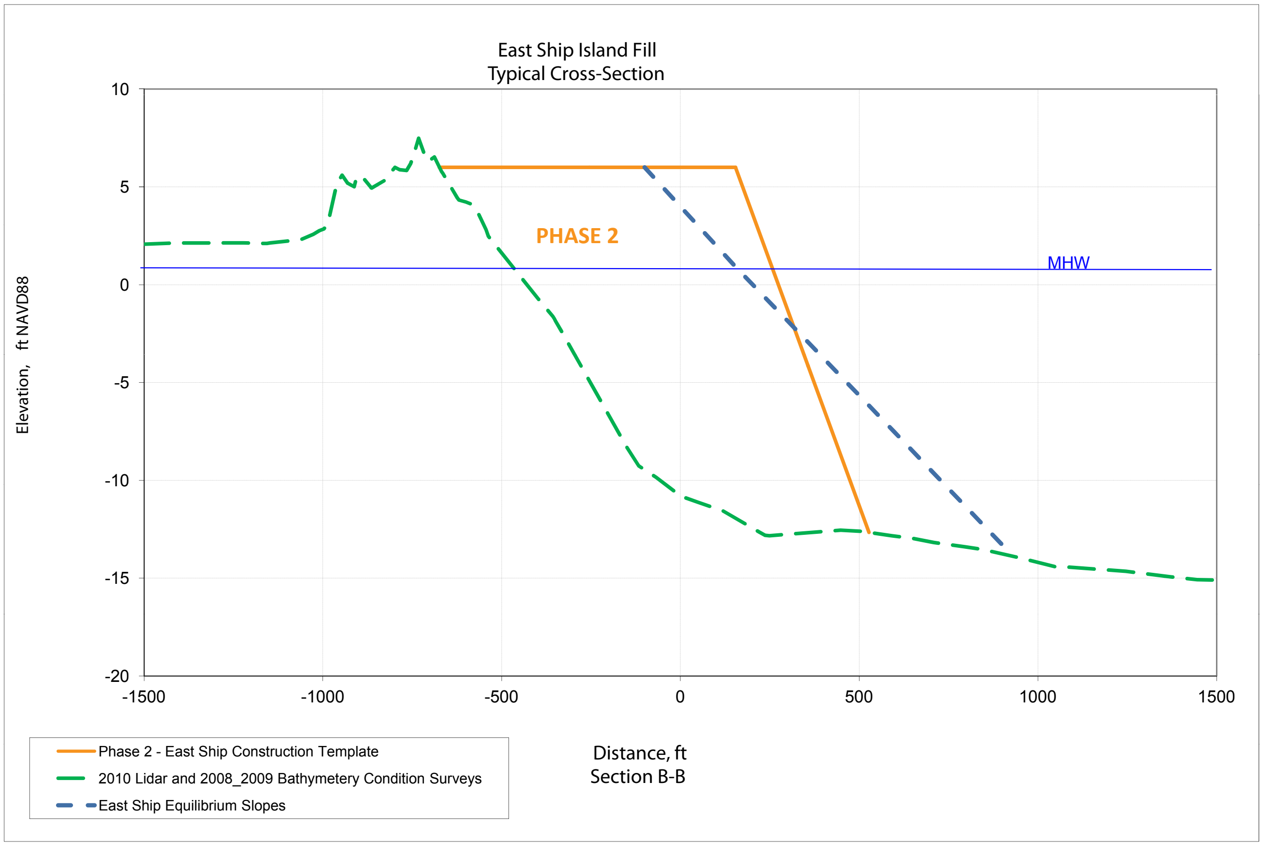


Typical Construction Cross Section



Conceptual Drawing

FIGURE 3-20
CAMILLE CUT TYPICAL CROSS SECTION (A-A)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS



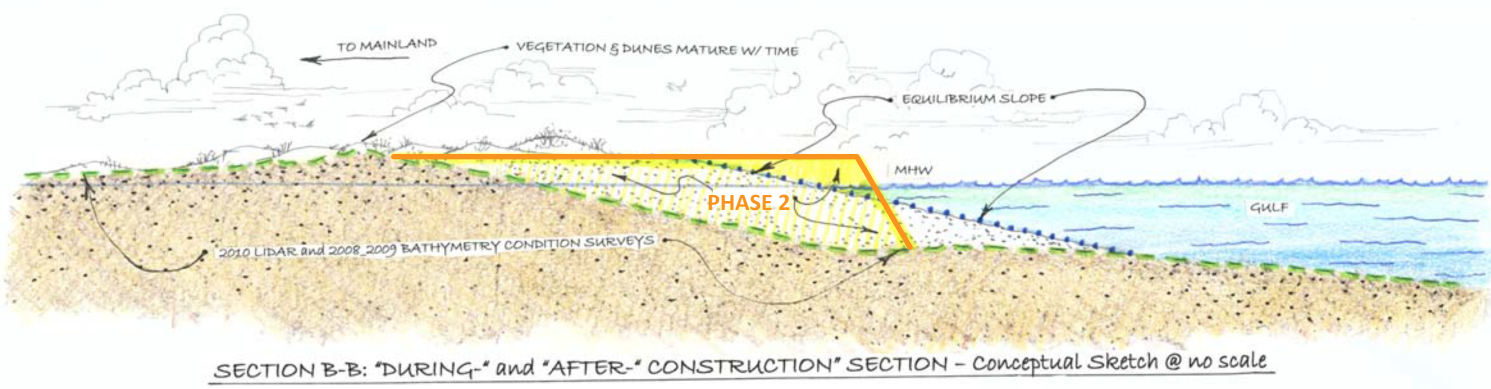


FIGURE 3-21
EAST SHIP ISLAND TYPICAL CROSS SECTION (B-B)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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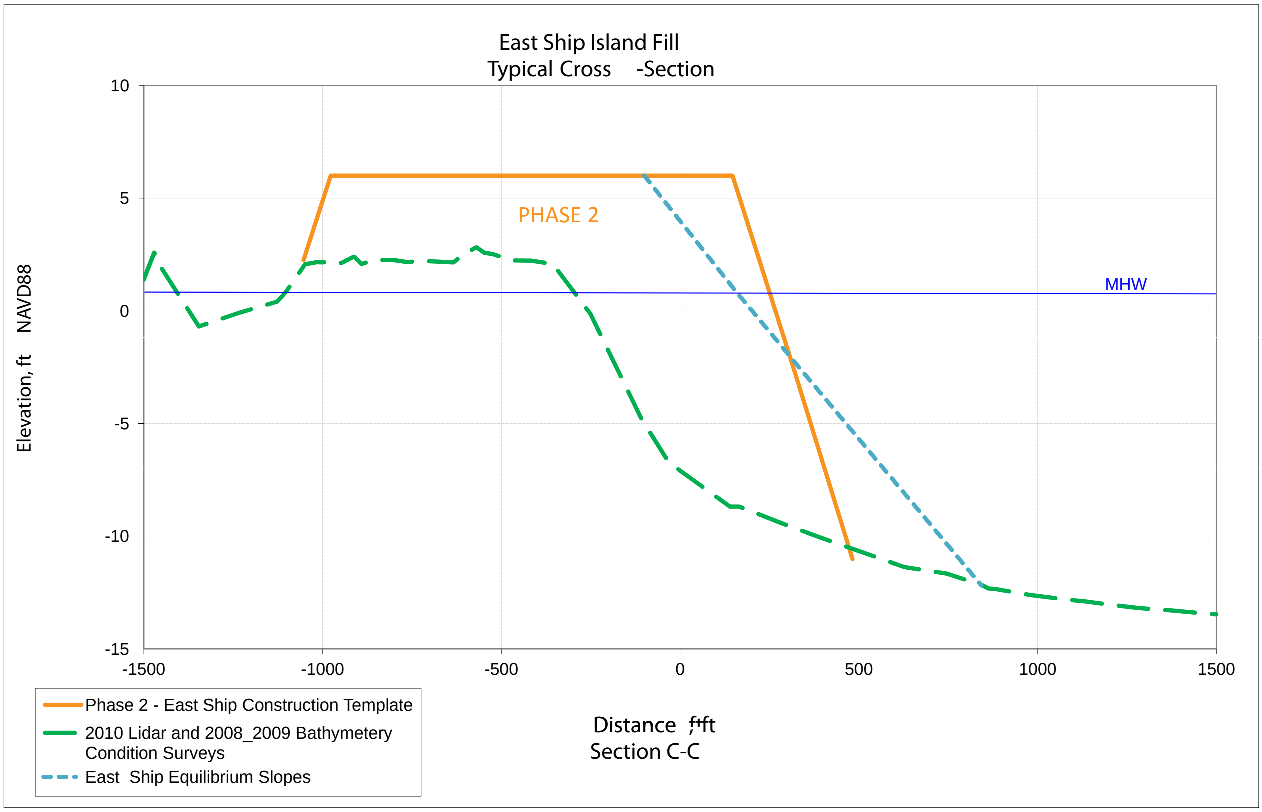
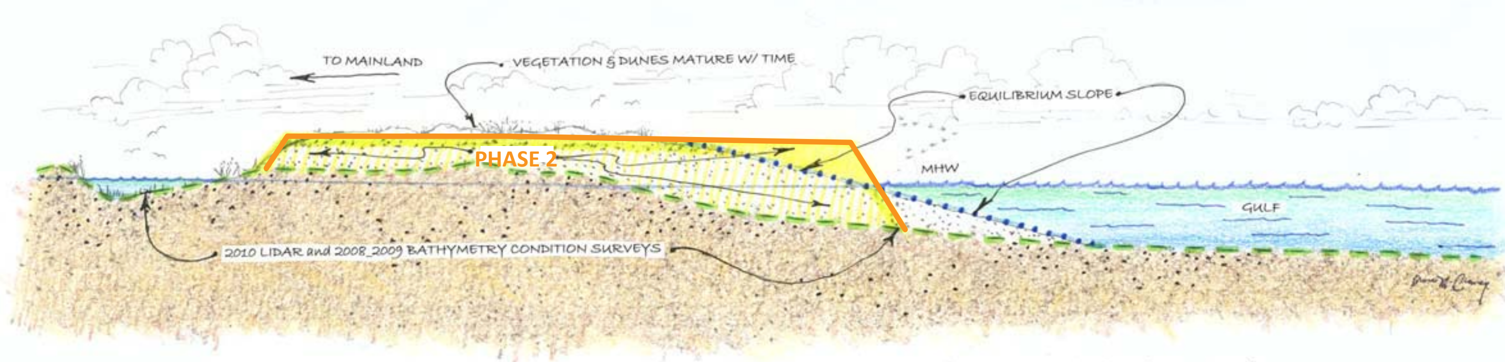




SECTION C-C: "DURING-" and "AFTER-" CONSTRUCTION" SECTION – Conceptual Sketch @ no scale

FIGURE 3-22
EAST SHIP ISLAND TYPICAL CROSS SECTION (C-C)
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

Borrow Site Option 4

Borrow Site Option 4 would use 19.0 mcy of sand dredged from five borrow areas for Camille Cut closure and restoration of East Ship Island. The borrow sites are Ship Island (1.2 mcy), PBP-AL (8.5 mcy), PBP-MS (2.0 mcy), PBP-OCS (4.1 mcy), and Horn Island Pass (3.2 mcy). The estimated rough order of magnitude cost of this option is $368 million.

3.4.2.2 Cat Island Restoration

Dune and beach restoration on Cat Island, including revegetation, would be implemented through the direct placement of 2 mcy of sand on the eastern beach fronting Cat Island (Figure 3-15). The recommended design was largely based on restoring the eastern shoreface of Cat Island to 1998 conditions. The construction template would include an average dune crest width of 40 feet at an elevation of approximately +7.5 feet NAVD88. The construction berm would have an average constructed crest width of 250 feet at an elevation of approximately +5 feet with a 1V:12H to 1V:20H slope from the seaward side of the berm to the toe of the fill. Direct placement of sand on the eastern beach would restore the island habitats, thereby enhancing the island's ability to absorb energy from westward-propagating waves. The construction profile is expected to adjust rapidly through the erosion of the upper profile and mimic the natural nearshore profile once it reaches equilibrium. The equilibrium design berm width averages 175–200 feet. The total equilibrated fill area encompasses approximately 305 acres.

Sand used in the restoration of Cat Island would come from a 282-acre sand deposit in an area about 2 miles long and 0.2-mile wide centered about 1.25 miles off the eastern shoreline of Cat Island (Figure 3-15). The borrow site would be east of the placement area and outside the GUIS boundaries. Geophysical survey data indicate that extensive sand deposits are available there (Appendix A). The borrow site would be dredged to a depth of 3–5 feet to minimize disruption of habitat and to minimize the effects of wave refraction over the site after excavation.

3.4.2.3 Management of Littoral Placement of Future Dredged Material from Pascagoula Federal Navigation Channel

The TSP recommends placement of the suitable sandy material dredged from the Horn Island Pass part of the Pascagoula Federal Navigation Channel from the existing location (Figure 3-16) in the combined DA-10 littoral zone along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Figure 3-17). The area of potential direct placement would encompass 1,600 acres between DA-10 and the southern boundary of the Pascagoula Harbor littoral zone placement site at depths of 5-30 feet. The deeper waters are required for hopper dredges that cannot operate on the shallow shoals for disposal. The optimum dredge placement location for hydraulic pipeline dredges is just southwest of DA-10. This area is preferred from both sediment transport potential and operational standpoints to minimize unnecessary pumping distances.

3.4.3 Other Borrow Alternatives Considered

Combined Borrow Site Options for Ship Island Restoration

Four combinations of borrow material were developed for use in the closure of Camille Cut and restoration of East Ship Island. These options use identical placement locations, design and engineering methods, and construction methods and phasing, but different combinations and parts of borrow area sites. The borrow volumes in Table 3-5 are based on the volumes that could be removed from each borrow site based on the typical dredging equipment inefficiencies (hopper dredges are 85 percent efficient) rather than the total volume of material available as listed in Figures 3-4 to 3-8 and 3-10 to 3-12.

TABLE 3-5
Potential Combined Borrow Areas for Camille Cut and East Ship Island Placement

Alternative ID	Borrow Area Volumes (mcy)							Rough Order of Magnitude Cost ($ million)
	Ship Island	DA-10/Sand Island	Horn Island Pass	PBP-MS	PBP- AL	PBP-OCS	Total	
Borrow Option 1	1.2	5.1	0	0	12.2	0	18.5	$402,000
Borrow Option 2	1.2	5.1	3.2	2.0	3.4	4.1	19.0	$330,000
Borrow Option 3	1.2	3.7	3.2	2.0	4.8	4.1	19.0	$341,000
Borrow Option 4	1.2	0	3.2	2.0	8.5	4.1	19.0	$363,000

PBP = Petit Bois Pass

All four borrow site options are viable sources of sandy material to be used to restore the barrier islands. The only differences among them are costs, access to the sandy material, and their specific locations—in Alabama, Mississippi, or the OCS. All four options are evaluated in Section 5. Borrow Site Option 4 was selected as the preferred borrow site option for the TSP. Borrow Site Option 1 is more expensive than other options and thus was not considered viable compared to the others. Borrow Site Option 4 is more costly than Options 2 or 3 because of the reduced/no use of borrow material from DA-10/Sand Island and higher use of sand from the PBP-AL site, which would require payment to the state of Alabama. Borrow Site Option 4 was selected to avoid using DA-10/Sand Island, because of concerns raised by NPS relative to impairment of GUIS resources and to be in compliance with NPS *Management Policies*.

3.4.3.1 Borrow Site Option 1

Borrow Site Option 1 would use 18.5 mcy of sand dredged from three borrow areas to close Camille Cut and restore East Ship Island: Ship Island (1.2 mcy), DA-10/Sand Island Area 1 (5.1 mcy), and PBP-AL (12.2 mcy). The rough order-of-magnitude cost of this option is $402 million.

3.4.3.2 Borrow Site Option 2

Borrow Site Option 2 would use 19.0 mcy of sand dredged from six borrow areas to close Camille Cut and restore East Ship Island: Ship Island (1.2 mcy), DA-10/Sand Island Area 1 (5.1 mcy), PBP-AL (3.4 mcy), PBP-MS (2.0 mcy), PBP-OCS (4.1 mcy), and Horn Island Pass (3.2 mcy). The rough order-of-magnitude cost of this option is $330 million.

3.4.3.3 Borrow Site Option 3

Borrow Site Option 3 would use 19.0 mcy of sand dredged from six borrow areas to close Camille Cut and restore East Ship Island: Ship Island (1.2 mcy), DA-10/Sand Island Area 2 (3.7 mcy), PBP-AL (4.8 mcy), PBP-MS (2.0 mcy), PBP-OCS (4.1 mcy), and Horn Island Pass (3.2 mcy). The estimated rough order-of-magnitude cost of this option is $341 million.

4. Affected Environment

The MsCIP PEIS (USACE, 2009a) characterized the affected environment of the overall MsCIP project area, which includes Hancock, Harrison, and Jackson Counties, Mississippi Sound, the Mississippi-Alabama barrier islands, and the nearshore Gulf of Mexico. The information in Section 4 of the PEIS is incorporated by reference into this section, which addresses the existing conditions of the sand borrow areas and the areas included in the TSP and the other restoration alternatives considered. Section 4.1 summarizes existing conditions within the project area, specifically the barrier islands. Subsequent sections describe the existing biological, physical, and chemical conditions, and socioeconomic conditions in the barrier island restoration project area (Figure 1-1) in greater detail.

4.1 Summary of Existing Conditions

The Mississippi barrier islands are dynamic coastal landforms that serve as the first line of defense between the Gulf of Mexico and the Mississippi mainland coast. The islands bear the full impact of atmospheric and oceanic energy from tropical storms and hurricanes passing through the region. They also contribute to the maintenance of the highly productive Mississippi Sound estuarine ecosystem. Hurricanes, variations in sediment supply, anthropogenic activities affecting littoral transport processes, and relative sea level changes have driven changes in island location and morphology and are reflected in the current conditions on the barrier islands (Appendix B).

The barrier islands have experienced substantial changes in shoreline position, configuration, and island landmass since the mid-1800s, and such changes continue to the present day (Appendix B; Morton, 2008). Lateral island migration (erosion along the eastern end of the islands and sand deposition to the west) and island narrowing and segmentation have occurred, driven by dominant east-to-west sediment transport and a net loss of sand to the littoral system from management activities at Horn Island Pass. Much of the littoral drift zone through which sand historically has migrated along the barrier islands is contained within the boundaries of the GUIS. Long-term land loss and morphological changes to the barrier islands affect their natural and historic resources. Moreover, loss of barrier island area threatens the ecosystem of Mississippi Sound, and exposes the mainland coast and its associated wetlands and coastal habitats to increasing saltwater intrusion and damage from future storms and storm surges (USACE, 2009a; Appendix D).

4.2 Environmental Setting

The environmental setting for the project includes the Mississippi coastline (Hancock, Harrison, and Jackson Counties), Mississippi Sound, and the Mississippi-Alabama barrier islands (Figure 1-1). From east to west, the islands are Dauphin Island in Alabama and Petit Bois Island, Horn Island, East Ship Island, West Ship Island, and Cat Island in Mississippi. The project area also includes the northern Gulf of Mexico to a distance about 8 miles seaward of the barrier islands to include offshore borrow material locations.

4.2.1 Mississippi Sound

The area is characterized by a humid subtropical climate and is partially isolated from the Gulf of Mexico. Average annual air temperatures are 66–68 degrees Fahrenheit (°F). The normal annual rainfall is 65–67 inches, distributed relatively evenly throughout the year. The area is subject to hurricanes from June through the end of November, with most occurring in August and September. In 1969, Hurricane Camille damaged the coastal area of Mississippi, and in 2005, Hurricanes Katrina and Rita damaged coastal areas from Galveston, Texas, through Mississippi and Alabama (USACE, 2010c).

Mississippi Sound is a shallow, estuarine body of water averaging 6–12 miles wide and extending approximately 90 miles along the coast from Mobile Bay, Alabama, west to Lake Borgne, Louisiana (Figure 1-1). The average mean low water depth of the Sound is 10 feet, and over 99 percent of the area is less than 20 feet deep (Gulfbase.org, 2010).

Several navigation channels traverse Mississippi Sound. The GIWW provides a shallow-draft navigation channel that parallels the mainland coast through the entire length of Mississippi Sound. Four deepened navigation channels extend into Mississippi Sound from Gulfport, Biloxi, Pascagoula/Bayou Casotte in Mississippi, and Bayou La Batre in Alabama. The USACE dredges the channels regularly. The deepest shipping channels are those connecting the ports of Gulfport and Pascagoula/Bayou Casotte to the Gulf of Mexico. The channels have authorized navigation depths of 36 and 44 feet, respectively, plus an additional 4 feet of advanced maintenance/overdepth dredging.

The barrier islands form the southern boundary of Mississippi Sound and are located approximately 6–12 miles offshore. Generally, the islands feature broad, sandy beaches to the north with dunes on the southern Gulf side. With the exception of Cat Island, barrier islands within the project area, including Dauphin, Petit Bois, Horn, and East and West Ship Islands, have migrated westward over time. These islands will continue to migrate, as a result of the littoral drift zone that moves sand from east to west across the barrier island chain (Morton, 2008; Appendix B). The barrier islands and surrounding waters contain important natural, cultural, and recreational resources. They include habitat for approximately 25 endangered and threatened animals in diverse ecosystems, serve as critical nursery habitat for marine flora and fauna, serve as a stopover for migratory birds, and provide recreational opportunities (NPS, 2010a).

The benthic habitat within Mississippi Sound and the barrier islands provides a wide range of environmental conditions for macroinvertebrate assemblages. The composition and density of macroinvertebrates are influenced by a number of factors, including wave action, sediment properties (primarily percent sand), turbulence, salinity, dissolved oxygen (DO) (the occurrence of hypoxia), water depth, the occurrence and frequency of tropical storms/ hurricanes, and seasonal variability. For example, at the barrier islands, benthic habitat and corresponding benthic community varies from “protected” beaches on the north or Sound sides of the islands to “exposed” beaches on the south or Gulf of Mexico sides of the islands (Appendix I; Rakocinski et al., 1991).

Waters in Mississippi Sound are influenced by saline gulf waters flowing into the Sound between the barrier islands, as well as freshwater drainage from 20,000 square miles of mainland watersheds. Larger rivers draining into Mississippi Sound near the project include the Pearl, Pascagoula River, and Mobile Rivers. However, the Pascagoula River is the only river that discharges directly to the Sound and has the most influence on freshwater inflows. The mix of freshwater and saline conditions has created a dynamic estuarine environment (NOAA, 2004). Most of the Mississippi barrier islands are part of GUIS (Section 1.3; Figure 1-1) (NPS, 2010a). Within the project area, GUIS includes parts of Cat Island and all of West and East Ship, Horn, and Petit Bois islands. Part of Cat Island is privately owned and also within the project area. GUIS was established to preserve the barrier islands, salt marshes, wildlife, historic structures, and archaeological sites found along the islands. The barrier islands are dynamic land forms that act as the interface between the ocean and Mississippi Sound. As such, the islands help to maintain the estuarine conditions in the Sound and provide a buffer to the mainland for hurricanes and major storms.

4.2.2 Outer Continental Shelf

The outer continental shelf (OCS) extends off the coast of Mississippi and Alabama approximately 70–80 miles. Within the project area, the continental shelf is generally flat, and depths range from 24–60 feet. Beyond the project area, the shelf is bathymetrically diverse and includes slopes, escarpments, knolls, basins, and submarine canyons (NOAA, 2004). Water depths are up to 590 feet (180 meters) at the edge of the shelf (Gulfbase, 2013). Circulation patterns of the mid-shelf and deepwater regions of the northern Gulf of Mexico are influenced by the Loop Current. The Loop Current is associated with the upwelling and high nutrient levels that result from ocean water flow from the Yucatan Channel and input of freshwater from rivers originating in the U.S. and Mexico (NOAA, 2010a).

The Gulf of Mexico marine ecosystem has experienced stresses as a result of shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading. Farther west of Mississippi Sound into the Gulf of Mexico, there is a regional occurrence of hypoxic waters. Productivity in hypoxic waters is much lower than in other regions of the Gulf. Hypoxia is known to occur in shelf waters off the Louisiana coast during the summer and extends to Gulf waters east of the Mississippi River as well (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, 2008; USEPA, 2008).

The nearshore area, including Mississippi Sound and the northern Gulf of Mexico, is used for commercial and recreational shipping, boating, and fisheries. A high number of oil and gas facilities, along with several fish havens, artificial reefs, and shipwrecks, are located in the area. These are considered important migration areas for marine mammals, such as the Atlantic bottlenose dolphin (*Tursiops truncatus*), and coastal birds, such as the brown pelican (*Pelecanus occidentalis*), and are used as foraging habitat for Gulf sturgeon. Deeper water areas (> 98 feet) to the south of the barrier islands contain important commercial fish and shrimp fisheries, fish havens, shipwrecks, and offshore banks. Oil and gas activities occur south of the barrier islands. Pipelines running north/south between Horn and Petit Bois Islands and between Petit Bois and Dauphin Islands link these areas to the coast (BOEM, 2010).

4.3 Physical Environment

This section describes the physical environment in the barrier island restoration project area, including physiography, bathymetry, meteorology, hydrology and coastal processes, and sediment characteristics. These elements are described by the major physiographic units in the project area, including the mainland Coastal Plain, Mississippi Sound, and the barrier islands and natural passes.

4.3.1 Physiography

4.3.1.1 Coastal Plain

Areas in Mississippi landward of the northern shore of Mississippi Sound have been characterized as belonging to the "Outer Coastal Plain Mixed Forest Province Ecoregion" (USDA, 1995). Areas near the Sound have further been characterized as belonging to either the Gulf Coast Flatwoods, an irregular belt of lands consisting primarily of wet lowlands intermingled with some smaller zones of better drained uplands, or the Southern Lower Coastal Plain, a zone of undulating interior uplands. Land elevations range from sea level along the Sound up to 400 feet NAVD88 to the north (USACE, 2009a).

4.3.1.2 Mississippi Sound

USFWS (1982a) described Mississippi Sound as a 100-mile long lagoon system bounded on the west by Lake Borgne, Louisiana, and on the east by Mobile Bay, Alabama. The northern boundary is the Louisiana, Mississippi, and Alabama mainland coast. The southern boundary is the chain of barrier islands consisting of, from east to west, Dauphin Island, Petit Bois Island, Horn Island, East Ship Island, West Ship Island, and Cat Island. Mississippi Sound, the barrier islands and their related passes, and the locations of relevant major navigational channels across the Sound are shown on Figure 1-1.

4.3.1.3 Barrier Islands and Natural Passes

The Mississippi barrier islands were formed during the mid- to late Holocene period by gradual nearshore sediment aggradation of sand and mud from coastal areas and Mobile Bay. A relict late Pleistocene barrier ridge on the western flank of the Mobile Bay entrance became the intermediate base that enabled continued westward sand transport by littoral drift and currents off (and parallel to) the mainland shore. As rising waters surrounded the elevated ridge, an apron of beach and dune sand encircled and partially covered it. The ridge turned into the core of eastern Dauphin Island. Dauphin Island then became the transmission site for large volumes of littoral sand. From this island, the rest of Dauphin Island aggraded and extended westward as a narrow, shore-parallel sandy shoal platform off Alabama and Mississippi. This elongated barrier platform belt extended well into southeastern Louisiana (Otvos and Giardino, 2004). The typical island profile includes:

- An average width of less than a half-mile
- A Gulf-side broad beach backed by dunes
- Intermittent beach and marsh zones in the interior of the island
- An additional dune bank on the mainland side

Dune heights typically do not exceed 20 feet or so except on the eastern end of Dauphin Island, where dunes may reach 40 feet (USACE, 2007a). Gulfward of the barrier island shoreline, the bottom slopes fairly rapidly to depths greater than 20 feet within short distances from shore (USACE, 2007a). Substantive variations on these typical characteristics exist.

Byrnes et al. (2012) evaluated barrier island processes and determined that shoreline and beach evolution for the barrier islands fronting Mississippi Sound is driven by longshore transport processes associated with storm and normal wave and current conditions. Although beach erosion and washover deposition are processes that have influenced island changes, the dominant mechanism by which sand is redistributed along the barrier islands and in the passes is the longshore currents generated by wave approach from the southeast.

Barrier islands fronting Mississippi Sound have been losing surface area through time, proceeding rapidly to the west, except for Cat Island, which appears to be isolated from the east-to-west sediment transport system. The barrier islands are losing their capacity to reduce risk to mainland beaches, and infrastructure. Shoreline data were used to compare recent shoreline changes with historical trends relative to storms and sea level. The analysis indicated that historical change trends for the barrier islands will continue as a result of rising sea level, frequent intense storms, and reduced sand supply (Morton, 2008; Appendix B).

4.3.1.4 Outer Continental Shelf

The OCS extends 70–80 miles off the coast of Mississippi and Alabama and reaches depths of up to 590 feet (180 meters). The area between the Mississippi Delta near Biloxi and the eastern side of Apalachee Bay in Florida is characterized by soft bottom sediments (Gulfbase, 2013).

4.3.2 Meteorology

Coastal Mississippi is characterized by a mild and humid climate. Coastal areas of Mississippi typically experience mild temperatures. The coldest air temperatures occur in January, the warmest in July or August. Based on monitoring records of the Southeast Regional Climate Center (SRCC), the average maximum temperature in July varies from 89.6–90.9°F, and the average minimum temperature in January varies from 41.2–43.3°F. Localized variations in temperature occur because of the varied influences of proximity to the land/water interface.

Long-term rainfall records maintained by SRCC for Gulfport, Biloxi, and Pascagoula document that the region receives more than 65 inches of rainfall annually, with monthly averages generally ranging from 5–6 inches. The highest monthly rainfall totals typically occur during July and August.

The relatively even distribution of rainfall accumulations may be attributed to the occurrence and frequency of winter frontal storms balanced against thunderstorms during the wetter, summer months. Regional rainfall records are important sources of information on conditions within the project area because they reflect the availability of watershed accumulation of runoff and subsequent tributary water and sediment deliveries to Mississippi Sound.

Prior characterizations of wind conditions in the project area indicate that prevailing nearshore surface winds are from the south from March to July, gradually shifting to more easterly in August and September. In winter, prevailing winds are from the north and associated with frontal systems (USEPA, 1986).

Frontal storm systems occur about weekly in the winter and have a substantial effect on Mississippi Sound. Preceding the cold fronts, low barometric pressures typically generate onshore winds that drive water levels in the Sound higher. In combination with wind-driven waves, the elevated water levels contribute to flooding of beach zones and increased erosional impacts along the mainland and barrier island beaches. The wind and wave patterns reverse as storm fronts move through the area, leading to the waters of the Sound being forced into the backsides of the barrier islands and out of the Sound through the passes between the islands. USGS (2006) indicated that these storm-related wind and wave patterns contribute to erosional effects on both sides of the barrier islands and on the mainland shorelines. Modeling conducted for this SEIS (Appendix C) found that cold fronts resulted predominately in westward transport rates between 2,000 to 9,000 cy/yr on the Sound side of Ship Island. Computed model gradients of existing conditions suggest a tendency of accretion along the central section and a tendency of erosion along both ends of the Sound side of West Ship Island because of cold fronts (Appendix C).

The northern Gulf of Mexico experiences tropical storm and/or hurricane force storms on a routine basis. Tropical storms have historically made direct landfall in the Biloxi to Pascagoula area every 10–12 years or so (Appendix B). The major impacts associated with Hurricane Katrina in 2005 are well documented and prompted development of the MsCIP Comprehensive Plan.

During tropical storms and hurricanes, physical conditions within Mississippi Sound and the adjacent barrier island system diverge radically from prevailing conditions. Combinations of extreme wind, wave, and current conditions create erosional and depositional forces that can cause changes in the physical environment of the barrier islands and Mississippi Sound. These changes in turn can cause measurable impacts to the flora and fauna of the Sound as well as the wetland and upland habitats on the mainland.

4.3.3 Hydrology and Coastal Processes

4.3.3.1 Coastal Plain

Hydrologic characteristics of the Coastal Plain watersheds that drain to Mississippi Sound are described by USGS (Wilson et al., 2009). The three basins are the Pascagoula River basin, the Coastal Streams basin, and the Pearl River basin. The Pascagoula and Pearl River basins are somewhat similar in terms of overall area, but the Coastal Streams basin is considerably smaller. The Coastal Streams basin includes the Wolf and Jourdan Rivers, which are tributaries to Bay St. Louis, and the Biloxi and Tchoutacabouffa Rivers, which are tributaries to Biloxi Bay. Of the three basins, the Pascagoula River basin is the largest contributor of fresh water directly to the Sound. The Pearl River basin is similar in overall area and discharge, but much of its freshwater influence is dispersed between Lake Bourne, Mississippi Sound, and the open Gulf of Mexico to the south and east of the point of river discharge. The contribution of the Coastal Streams basin is substantially smaller than those of the other two basins with respect to freshwater inflow and cumulative influence on the estuarine water quality of Mississippi Sound.

NOAA estimated that just over 882.4 cubic meters of fresh water flows into Mississippi Sound per second (Moncreiff, 2006). Approximately half of that enters the Sound though the Pascagoula River basin, with the remainder representing the net contributions of the Coastal Streams and Pearl River basins to the west. Historical inflows are highly variable, depending on annual weather patterns. Hydrologic variability contributes to the wide range of salinity regimes and associated water quality within Mississippi Sound, as characterized in Section 4.4.1.

4.3.3.2 Mississippi Sound

Hydrologic characteristics of Mississippi Sound are strongly influenced by wind-driven currents in combination with tidal influences of the Gulf of Mexico. Tides within the Sound are diurnal, with an average range of up to 2 feet. The tides are strongly influenced by local bathymetry, local river discharges, and winds (Jarrell, 1981).

Tides across the northeastern parts of the Gulf of Mexico approach the coast from the south and enter the Sound through the natural passes between the barrier islands. Because of the relative depths of the coastal areas offshore of the barrier islands, tidal influence tends to penetrate the Sound near Petit Bois Island sooner than through the passes to the west. This results in tidal wave fronts to the west of Petit Bois Island propagating to the north and northwest, while those to the east of this system divide more to the east. Kjerfve and Sneed (1984) described tidally based circulation in the eastern portion of the Sound as having a strong clockwise rotation. The western parts of the Sound are characterized by a weaker, counter-clockwise rotation. These circulation patterns would contribute to how the potential effects of barrier island restoration might be distributed within the Sound, depending on proximity of the restoration activities to the passes where tidal inflow and outflow would transport any suspended materials. In addition, approximately 25 percent of the flows into Mobile Bay enter far eastern Mississippi Sound through Pas aux Herons.

The influence of winds on coastal currents both within the Sound and on the Gulf side of the barrier islands is well documented (Morton et al., 2004; Appendix B). Wind-driven waves and associated currents were identified as the primary mechanisms driving sediment transport. Prevailing winds from the south and east drive currents toward the west (Cipriani and Stone, 2001). While much of the literature focuses on the east-to-west currents being major factors in influencing barrier island migration westward and to some degree landward, these same factors influence localized current speed and direction on the Sound side of the islands.

4.3.3.3 Barrier Islands and Natural Passes

Relevant hydrologic and coastal processes associated with the barrier islands relate primarily to the effects of waves and longshore currents on island stability over time. As noted, the prevailing winds and resultant longshore currents are the drivers behind the net east-to-west sand transport for any given island, as well as for the overall island system under evaluation. Wave energy is a key factor in sediment resuspension and promotion of lateral transport through longshore water movements.

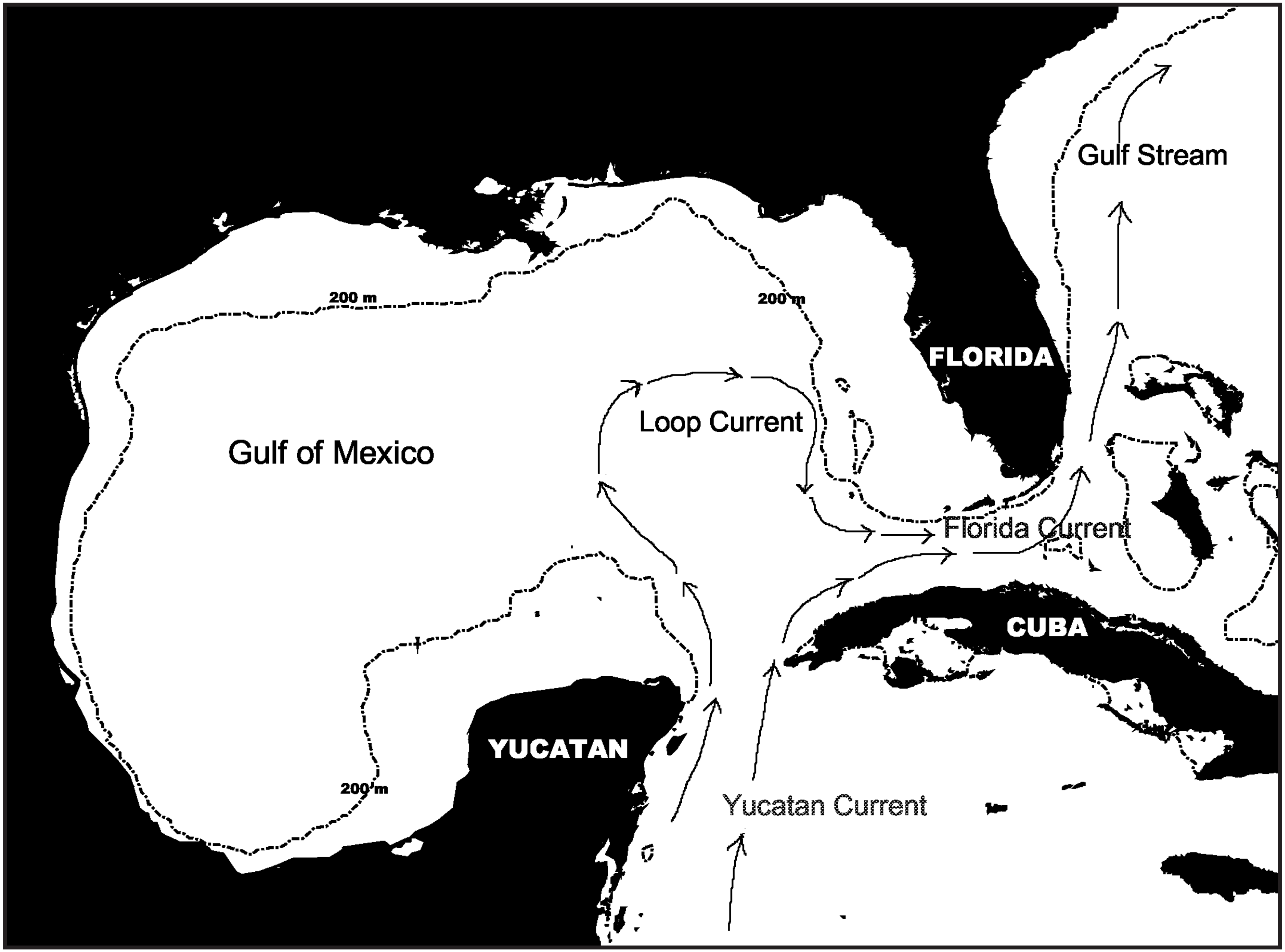
Major sediment movements are considered to be storm-related where winds and associated waves and currents are forceful enough to cause both longshore transport and sand movements through the passes between the islands (Byrnes et al., 2010; Appendix B). Generally, the Gulf coast is considered a low energy coastal system, and typical wave heights on the barrier islands range from only 1–2 feet (Cipriani and Stone, 2001). During tropical storms, however, major episodes of sediment movement have been shown to be capable of making significant changes to island position or pass stability within very short periods of time. Further, winter frontal storms can at times create sufficient force to impact the mainland-facing margins of the barrier island system (USACE, 2009a and Appendix C) and the discharge rates from the Sound to the Gulf following major storms. Under storm-related flow modifications, tidal scour through the passes and along the barrier island margins can be substantial. Typical tidal currents range from 0.5–1.0 foot per second (USACE, 2009a). Seim et al. (1987) noted that tidal wave energy reflects “diffraction patterns radiating from the inlets . . .” Existing pass configurations thus influence tidal energy dissipation and associated potential for changes in the localized directions and magnitude of sediment transport.

A historical analysis of the sediment transport between 1917–20 and 2005–10 (single data set for study collected over a several-year period) documented an average sand flux of 300,000–400,000 cy/yr through the system extending from Dauphin Island in Alabama to West Ship Island (Byrnes et al., 2010; Appendix B). Consistent with prior studies, longshore transport was the dominant mechanism, and transport generally was east to west along the islands. Transport rates decreased toward the western end of the system. The littoral system includes four historical channels or passes between the islands: Petit Bois Pass, Horn Island Pass, Dog Keys Pass, and Ship Island Pass. Two of these passes, Horn Island Pass and Ship Island Pass, are navigable and are maintained by dredging. Additional hydrodynamic and morphological modeling performed on the project area found similarities in the magnitude of the transport rates, though on the lower end of other studies with deviations in ranges within the uncertainty ranges identified in the analysis (Appendix C). By comparison, the modeled average annual net transport rate on the south side of Ship Island is estimated to be 10,000–120,000 cy/yr vs. 2,000-9,000 cy/yr on the north side of Ship Island (Appendix C). When factoring in the uncertainties these values can be up- or down-scaled with a factor of 0.5 to 3.5.

4.3.3.4 Outer Continental Shelf

The hydrology of the Mississippi-Alabama shelf reflects several external forces. These include wind, major storms and hurricanes, the Gulf Loop Current (and its northern plumes and gyres), and other deepwater currents of the Gulf (Minerals Management Service [MMS], 1991). The general circulation pattern in the area seaward of the Mississippi Barrier Islands to the edge of U.S. territorial waters at 12 nautical miles from the baseline suggests that a combination of wind-induced circulation, currents, discharge of water from the Mississippi River, and tidal motion around the Chandeleur-Breton Sound estuary and Mississippi Sound interact to produce a clockwise gyre (USGS, 1982).

The Loop Current is a major oceanographic phenomenon affecting offshore circulation in the Gulf of Mexico (Figure 4-1). Water enters the Gulf through the Yucatan Strait between Cuba and the Yucatan Peninsula in Mexico, circulates clockwise as the Loop Current, and exits through the Florida Strait between the Florida Keys and Cuba, eventually joining the Gulf Stream. Closed rings of clockwise-rotating water often break away from the Loop Current, forming eddies or gyres which affect regional current patterns. Even though most of the Loop Current occurs in deep water, strong winds and currents affect the northeast Gulf of Mexico. The Loop Current can cause strong eastward upper level currents and warmer water temperatures between the Mississippi Delta and the De Soto Canyon (Thompson et al., 1999). Plumes associated with the Loop Current occasionally intrude across the shelf and can result in replacement of most of the shelf water within a few days (MMS, 1991).



Source: http://www.wbrz.com

FIGURE 4-1
LOOP CURRENT
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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4.3.3.5 Sea Level Rise

Systematic long-term tide elevation observations suggest that the elevation of oceanic water bodies is gradually rising and this phenomenon is termed “sea level rise.” The rate of rise is neither constant with time nor uniform over the globe. In addition to elevation of oceanic water bodies, however, is the gradual depression of land surface along the coast of Mississippi, referred to as “subsidence,” which becomes an additional factor in the relationship between the land’s elevation over time and changing sea levels. Because the coast of Mississippi is affected by both subsidence and global sea level rise (adjusted for local conditions), these factors combine in a single element of “relative” sea level rise. Relative sea level rise at a given location is the change in mean sea level at that location with respect to an observer standing on or near the shoreline. Analysis of historical data suggests a relative sea level rise of approximately 9 inches along the Mississippi coast during the 20th century.

Barrier islands are among the most vulnerable areas to the consequences of climate change. Serious threats to the islands come from the combination of elevated sea levels and intense hurricanes. The Mississippi barrier islands consist primarily of low-lying topography with beach-ridge interior cores near the hurricane-prone Gulf of Mexico. As a result, the barrier islands are more susceptible to the effects of storm surge than other areas. Rising sea levels result in pushing the high-water mark landward, potentially causing the islands to migrate slowly inland provided that sufficient sediment supply is available and the rate of sea level rise is such that the islands can keep pace. Losses could be accelerated by a combination of other environmental and oceanographic changes such as an increase in the frequency of storms and changes in prevailing currents, both of which could lead to increased beach loss through erosion (Antonelis et al., 2006; Baker et al., 2006). This could translate into continued loss of valuable habitat along the Mississippi barrier islands, including sea turtle nesting habitat, shorebird foraging and roosting areas, dune habitat supporting various flora and fauna, and general island ecosystem functions.

Under low to moderate rates of relative sea level rise, barrier islands typically do not lose their entire land mass, because eventually they become so low and narrow that surficial processes are dominated by storm overwash (Morton, 2008). Sand eroded from the open-ocean shore in this state would be transported across the barrier island and deposited in the Sound to the north. The western three-fourths of Dauphin Island is a transgressive landform. The Mississippi barrier islands of Petit Bois, Horn, and Ship Island, however, are dominated by alongshore sediment transport. The predominance of westward alongshore sand transport both at geological and historical time scales indicates that this motion will likely continue in the future, being driven by the prevailing winds, storm waves, and associated currents (Morton, 2008). Byrnes et al. (2012) found that under historic rates of sea level rise, potential shoreline recession on the island(s) due to sea level rise accounted for 4–5 percent of the total island change signal. The remaining signal was driven primarily by the prevailing winds, storm waves, associated currents, and sediment supply.

Recent climate research by the Intergovernmental Panel on Climate Change (IPCC) predicts continued or accelerated global warming for the 21st Century and possibly beyond, which will cause a continued or accelerated rise in global mean sea level. Based on the historic rate of sea level rise taken from the NOAA tide station located at Dauphin Island, Alabama of approximately 0.01 ft/yr, sea level over the next 50 years is projected to rise approximately 0.4 foot from present day. Accounting for potential accelerated rise in global mean sea level in the future, it is projected that sea level over the next 50 years could increase as much as 0.8 foot–2.0 feet based on the 1987 National Research Council's (NRC) low and high curves modified with the IPCC current estimate of historic global mean sea level change rate. Island recession due to sea level rise projections based on the Brunn rule for erosion (Brunn, 1962) could range from 1.3 feet/year to upwards of 3 feet/year. In light of island background recession rates of 15–32 feet/year documented in Byrnes et al. (2012), the primary drivers of morphologic change during this period likely will continue to be sediment availability, prevailing winds, storm waves, and associated currents. The MsCIP barrier island restoration component seeks to minimize the island land losses by placement of sediment back into the most crucial areas of the system.

4.3.4 Bathymetry

4.3.4.1 Mississippi Sound

Depths within Mississippi Sound are highly variable, but generally shallow. Blumberg et al. (2000) described two different regions within the Sound in terms of relative depths. The northern and western parts of the Sound were described as shallow, with depths ranging from 3–9 feet. Greater depths are found in the east, central, and southern portions of the Sound, with a mean depth of about 13 feet. In the vicinity of Pascagoula, natural depths in the Sound are generally less than 13 feet, whereas the Sound deepens toward the Gulf to approximately 20 feet (USACE, 2010c).

A combination of natural and constructed channels is found between the barrier islands. Petit Bois Pass, located between Dauphin Island and Petit Bois Island, and Dog Keys Pass, located between East Ship Island and Horn Island, are natural, relatively shallow passes. In contrast, Horn Island and Ship Island Passes have been modified by navigational channel construction and maintenance to support commercial uses and are as deep as 64 feet. The Pascagoula Federal Navigation project, which extends through Horn Island Pass near the west end of Petit Bois Island, is to an authorized depth of 44 feet; the channel through the pass is dredged to a total depth of 48 feet, which includes the plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. To the west, the Gulfport Federal Navigation project, which extends through Ship Island Pass near the west end of West Ship Island, is authorized to 38 feet; the channel through the pass is dredged to a total depth of 42 feet, which includes the plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. Maintained channels penetrate the natural passes, which through natural tidal scour in some areas would normally exist to depths ranging from 10–35 feet, depending on position within these natural passes and proximity to natural tidally scoured zones (USACE, 2007a). In addition, a natural channel in Dog Keys Pass between East Ship Island and Horn Island leading toward Biloxi is approximately 15 feet deep; however, depths in this area are highly variable and the channel is not marked for navigation. To the north of the barrier islands, the GIWW extends from east to west through the Sound. The GIWW is a channel authorized to 12 feet deep and 150 feet wide; the channel is dredged to 18 feet, which includes plus 2 feet of advanced maintenance and plus 2 feet of overdepth dredging.

4.3.4.2 Outer Continental Shelf

Depths increase seaward of Mississippi Sound and the barrier islands. Within the project area, depths range from 24–60 feet. The continental shelf is bathymetrically diverse and includes slopes, escarpments, knolls, basins, and submarine canyons (NOAA, 2004). Water depths are up to 590 feet (180 meters) at the edge of the shelf (Gulfbase, 2013).

4.3.5 Sediment Characteristics

4.3.5.1 Coastal Plain

The geological and soils features within the Coastal Plain consist of sedimentary rock and sediments deposited during the Cenozoic Era. Materials consist of limestone overlain by layers of gravel, sands, and finer-grained sediments (silt and clay). Otvos (1994) described these materials as alluvium and terrace deposits. There are three geologic formations recognized within the Coastal Plain of Mississippi: the Biloxi Formation (clay, sand, and sandy clay with abundant fossils); the Prairie Formation (sand and muddy sand mixed with organic matter); and the Gulfport Formation (sand deposited along the land/water interface during a period of sea level decline) (USACE, 2009a).

4.3.5.2 Mississippi Sound

A detailed description of the geological history of Mississippi Sound and its surrounding areas is presented by Otvos and Giardino (2004) and Otvos and Carter (2008). The general coastal zone, including the Sound, is part of an interdeltaic province which has experienced extended periods of inundation during times of elevated sea level and subsequent periods dominated by erosion during times of lower sea level. During such erosional periods, river discharges cut trenches out to the Gulf through the deltas, and these trenches in turn were then filled with marine sediments during subsequent periods of higher sea levels (Velardo, 2005; USACE, 2010c).

More recently deposited sediments of Mississippi Sound are attributed to a combination of sediment deliveries to the Sound through river discharges associated with the Mississippi and Mobile Rivers, and the smaller river systems located between these two major systems. Those include the Pascagoula, Biloxi, Tchoutacabouffa, Jourdan, Wolf, and Pearl Rivers. It is believed that most of the sediments deposited in the Sound originated in the Appalachian Mountains (Velardo, 2005). However, tidal flows result in sediment transport into as well as out of the Sound through the inter-island passes. The influence of major tropical storms on barrier island overwash and sediment movements into the Sound at the passes is well documented. Ludwick (1964) described the sediments of the Sound as predominantly sandy mud, but with regions of clean sands found near the passes between the barrier islands. Upshaw et al. (1966) indicated the following:

- Central portions of the Sound were primarily silt and clay (<62 microns [μm]).
- In the Pascagoula area, medium-grained sands (>250 μm) were more prevalent.
- Coarse-grained sands occur in the vicinity of the barrier islands.

Fine-grained muds tend to accumulate in dredged channels within the Sound. According to Otvos (1973), mixed mud/sand areas are found west of Cat Island, between eastern Horn Island and Pascagoula, and between Biloxi Bay and Dog Keys Pass. This substrate mosaic typifies coastal lagoon systems, within which varied influences of mainland drainage and coastal processes contribute to sediment zonation in relation to material sources and routine or event-based sediment migration into and out of the system.

4.3.5.3 Barrier Islands and Natural Passes

Rosati and Stone (2009) provided a review of the literature on barrier island geomorphology in the northeastern Gulf of Mexico and differentiated the islands of the Alabama and Mississippi coastal zone from those to the east in Alabama and Florida, and to the west in Louisiana. Barrier islands off Louisiana are derived from former deltaic lobes of the Mississippi River, and a major factor in island stability is substrate subsidence and erosion. In contrast, subsidence in particular is viewed as much less of a factor for the islands of Mississippi, Alabama, and Florida. To the east, the Florida barrier islands are more stable in configuration, in part due to their proximity to more stable continuing sources of littoral sediments.

The primary source of sediment to barrier islands and passes fronting Mississippi Sound is sand transported west from western Florida and coastal Alabama beaches. Local sources of sediment to the barrier islands are eastern Dauphin Island and the Mobile Pass ebb shoal complex (Otvos and Giardino, 2004). Analysis of historical data indicates that sand supplied to the Mobile Pass ebb shoal complex is derived primarily from beach and nearshore sediment east of Mobile Pass (Byrnes et al., 2010).

Dauphin, Petit Bois, Horn, East Ship, and West Ship Islands represent a linked system in which sand transport occurs within the littoral drift zone from east to west along each island and from the west end of the updrift island to the east end of the downdrift island (Appendix B). Island migration rates to the west for Dauphin, Petit Bois, Horn, and Ship Islands reported by Byrnes et al. (2012) were 45.8, 25.7, 28.7, and 8.5 meters per year, respectively, for the period 1847–49 to 2010. Cat Island was described as the exception to the east-to-west sediment transport system. Cat Island is protected from offshore wave energy because of its position, which is somewhat sheltered by East Ship and West Ship Islands to the east and the Chandeleur Islands to the south (refer to Figure 1-1). Because of this sheltering, Cat Island is segregated from west-directed sand transport along the barrier islands. It is acknowledged that alternative judgments regarding the sand sources and transport quantities for these islands have been published. Cipriani and Stone (2001), using numerical modeling of normal wave processes, discussed evidence for each island having its own "cellular structure," with a sediment budget being maintained under normal conditions. They supported the concept that some sediments of central Petit Bois Island routinely are derived from offshore sources. This concept had previously been suggested by Otvos (1979), who concluded that the primary source of sediment for these islands was the shelf.

Beach sand on the barrier islands (Cat, West and East Ship, Horn, DA-10/Sand Island, and Petit Bois) is predominantly light gray in color, with grain size ranging from 0.21–0.48mm. The material on these islands ranges from fine-grained to medium poorly grained sand (Appendix A). The material from the borrow areas consists primarily of fine to coarse-grained sand with less than 10 percent fines. The range of mean grain sizes at the borrow sites is 0.20-0.33 mm, similar to the range of material at the placement sites: 0.21-0.48 mm. This sand size is consistent with that found on beaches of the Mississippi barrier islands. Tables 3-2 and 3-3 provide sediment characteristics for the potential borrow areas.

Overall, a majority of littoral sand supplied to downdrift beaches is derived from longshore transport during storm events (Appendix B). Therefore, restoration efforts updrift of Ship

Island or near the south shore of East Ship Island would enhance the longevity of littoral sand transport in the area.

4.3.5.4 DA-10/Sand Island

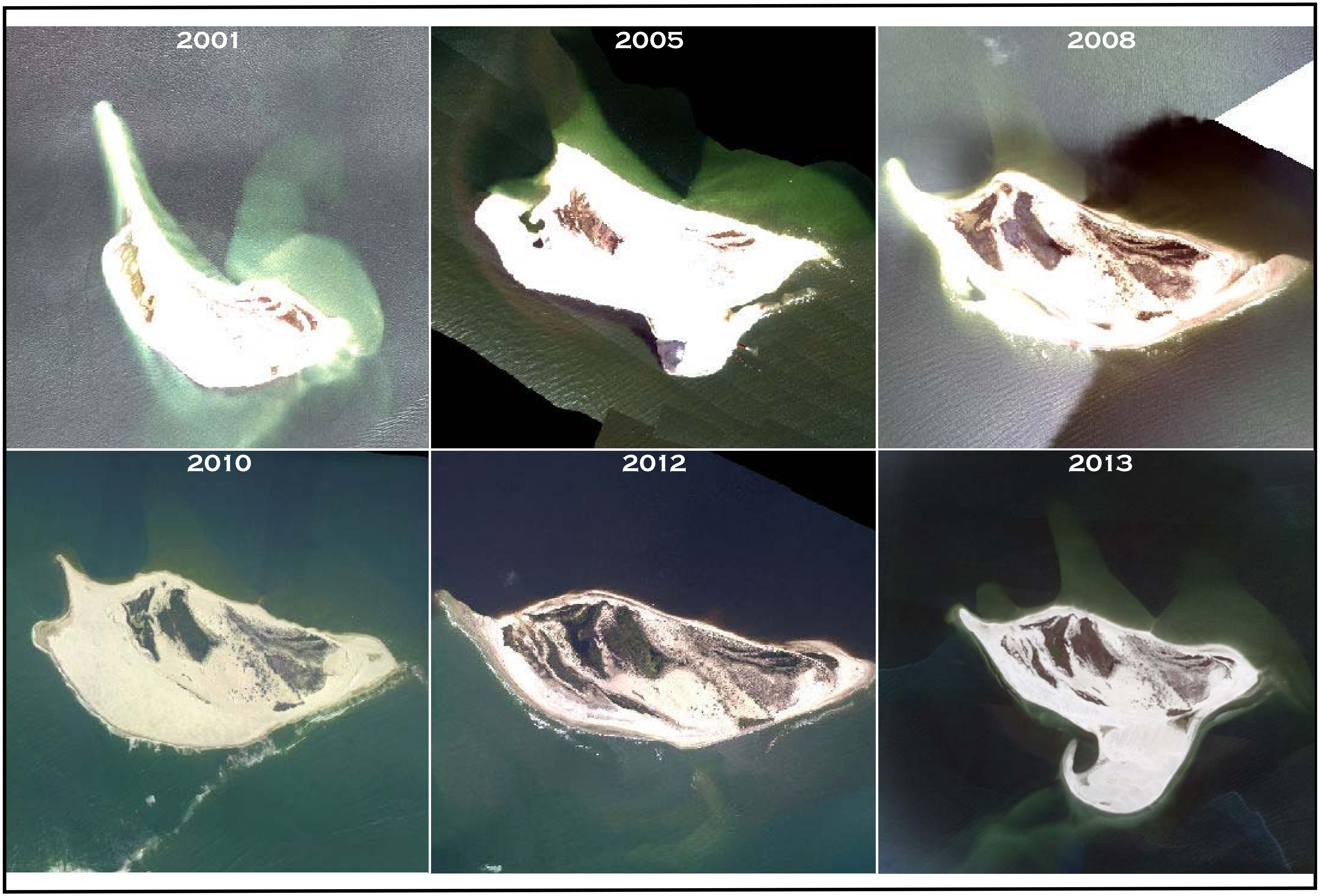
DA-10, which includes an island locally known as Sand Island, is an existing dredged material placement site for the Pascagoula Federal Navigation project, which has a subaerial portion. The island within DA-10 was created as the result of placement of dredged material in the disposal area. Between 1962 and 2009, changes in the configuration of the Pascagoula Bar Channel were implemented and placement of littoral sand dredged from the channel in DA-10 was performed frequently. Material dredged from the channel has been placed within DA-10 to maintain sandy sediment transport within the littoral drift. However, sand placement soon became subaerial as the amount of sand leaving the DA-10 via littoral transport could not keep pace with the amount of material being placed at the site (Appendix B). Consequently, a new island beach was established as a boundary along the western side of the navigation channel. The shape of this upland/island area has changed over time based on placements and sediment transport within DA-10 (Figure 4-2). Historically, material removed from the Pascagoula Federal Navigation project (i.e., Horn Island Pass section) was placed in the northern portion of DA-10 and eventually built the island to elevations as high as approximately +20 feet. Based on a better understanding of the littoral transport system in this area, the more recent method has been to place material at lower elevations (below +5 ft) off the southern end of the existing Sand Island.

4.3.5.5 Outer Continental Shelf

The bathymetry and subsurface sediment characteristics of the Alabama-Louisiana-Mississippi continental shelf south of the barrier islands reflect depositional sequences of delta outbuilding with intervening periods of erosion during low sea levels. Sediments in the area are associated with several different depositional periods. Surface sediments are generally sand enriched, averaging 56 percent sand with remaining sediments consisting of finer materials. Sediments in the area between Horn Island to approximately 5 miles seaward range from 50–75 percent sand and decrease in sand/increase in finer material further out. Sediments in the area between Petit Bois Island to approximately 10 miles seaward have high percentages of sand (>75 percent) and decrease to 50–75 percent beyond 10 miles (USGS, 1982).

4.3.6 Sediment Quality

Sediment quality was analyzed at 39 locations in Mississippi Sound following Hurricane Katrina (2005 and 2006) and compared to pre-hurricane (2000–2004) sediment data collected from 172 stations as part of the USEPA's National Coastal Assessment (NCA) program. This analysis identified no exceedances of effects range median sediment quality guideline values for chemical contaminants in any of the sediment samples collected from the Mississippi Sound study following the hurricane. At several stations, lower threshold effects range low values were exceeded for three metals—arsenic, cadmium, and nickel, but at levels similar to those observed prior to the hurricane (Macauley et al., 2010).



0 650 1,300 2,600 3,900 Feet

N W E S

FIGURE 4-2
HISTORICAL CONFIGURATION OF SAND ISLAND AT DA-10
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

In addition, the USACE Mobile District has routinely conducted sediment analyses on its federally authorized navigation projects, which include several within and near the MsCIP barrier island restoration effort. This material has been sampled using the protocols of the Inland and Ocean Testing manuals (USEPA and USACE, 1991) and found to meet ocean disposal criteria, based on physical, chemical, and biological parameters.

Following the Deepwater Horizon oil spill, USACE and USEPA jointly developed a testing protocol to analyze the spill's potential impact to USACE's Federal channels. In late 2010, sediment and water samples were collected and analyzed to characterize the physical and chemical quality of the proposed dredged material and disposal site(s). Physical sediment composition was described by grain size, Atterberg limits, specific gravity, total solids determinations, and unified soil classification. Chemical concentrations of polycyclic aromatic hydrocarbons, total organic carbon (TOC), and total petroleum hydrocarbons (TPH), including diesel-range organics, oil-range organics, and gasoline-range organics, were also identified in the sediment samples. Additionally, in June 2010, USACE conducted statistically random sediment testing in the borrow and placement areas that were under investigation at that time. Grab samples collected were analyzed for TPH.

Based on USACE-USEPA sediment and water sample results, no discernible changes in the sediment quality were attributable to the Deepwater Horizon oil spill. In more than 98 percent of the sediment samples collected during the USACE random testing from borrow and placement areas, concentrations of TPH were below method/laboratory detection limits. Random samples within the sampling grid were found to contain concentrations of TPH, but there was no pattern to the presence of TPH. These recent investigations, and past analyses, suggest a low likelihood of sediment contamination, and therefore low public health risk, around Mississippi Sound and the OCS. Based on USACE conversations with U.S. Coast Guard (USCG) and the lead of the Operational Science Agency Team (OSAT3), oil is unlikely to be present in offshore borrow sites; however, it has been reported that tar balls have repeatedly occurred on Sand Island.

The presence of tar balls on Sand Island is not expected to result in significant impacts to any biological resources using that area or the placement area. Tar balls are composed primarily of sand mixed with degraded oil product. These features are formed when the degraded oils become entrained within the surf zone and adhere to the sand particles. The repetitive movement within the surf zone causes the oil-sand particles to coalesce into balls of various shapes and sizes. The toxicity of these materials has been tested and, due to the degraded nature of the oils, is very low. As of March 2013, Sand Island is no longer part of the active oil spill response (Simonson, personal comm., 2013).

4.4 Water Quality

Water quality within Mississippi Sound is influenced by several factors, including the discharge of freshwater from rivers, seasonal climate changes, and variations in tide and currents. The primary drivers of water quality are the rivers that flow into the Sound, the largest contributors in the project area being the Pascagoula River, the Pearl River, and collectively the loading from the predominantly westward flow of the Mobile Bay system. Freshwater inputs from these major contributors and others such as the Wolf River, Escatawpa River, Biloxi River, and Jourdan River provide nutrients and sediments that serve to maintain productivity both in the Sound and in the extensive salt marsh habitats bordering the estuaries of the Sound. The salt marsh habitats act to regulate the discharge of nutrients from the mainland to coastal waters and serve as a sink for pollutants. Suspended sediments enter the Sound from freshwater sources but are hydraulically restricted due to the barrier islands. The barrier islands, combined with the Sound's shallow depth and mixing from wind, tides, and currents, promote resuspension of sediments. These suspended sediments give Mississippi Sound a characteristic brownish color (MDEQ, 2006a).

The dynamic features of this area create variations in many water quality parameters throughout the project area, including temperature, salinity, DO, sediment oxygen demand, nutrients, TOC, and others that influence the biological and ecological processes naturally occurring in the estuary. Temperature and salinity strongly influence chemical, biological, and ecological patterns and processes.

The State of Mississippi classifies the Gulf of Mexico as an estuary within Mississippi waters to the state boundary located 3 nautical miles south of the barrier islands. MDEQ designates a use classification for this area primarily as Recreation with a small area near the mainland as Shellfish Harvesting and Recreation (MDEQ, 2007). All waters are classified to support aquatic life. MDEQ has established numeric criteria for various water quality parameters to evaluate whether the waters support those designated uses.

MDEQ evaluates the water quality of the Sound based on the monitoring it conducts through the Mississippi Coastal Assessment Program (MCA). This program builds on the NCA program established by USEPA. The MCA monitors the same parameters as those monitored through the NCA program, and 25 sites are randomly selected each year for sampling during July, August, and September (MDEQ, 2010a).

4.4.1 Salinity

The salinity regime of Mississippi Sound is highly variable and characterized by multiple sharp fronts as a result of freshwater inflow from larger rivers, an irregular coastline with bayous, tidal flow through natural passes and navigation channels, and meteorological forces, such as wind (Kjerfve, 1986; Vinogradova et al., 2005). Salinity commonly varies from 20–35 parts per thousand (ppt) (Kjerfve, 1986). Average salinity is about 24 ppt (USEPA, 1999). Salinity levels are typically lowest along the mainland coast, where levels fluctuate more widely (Mississippi Department of Wildlife, Fisheries, and Parks [MDWFP], 2005) due largely to variations in freshwater inflow. During normal rainfall periods, the western Sound is fed by higher freshwater inflows from Lake Borgne, whereas the central Sound receives less freshwater inflow, circulates poorly, and experiences extensive tidal flushing through the barrier island passes. The eastern Sound receives freshwater river inflows primarily from the Pascagoula River and Mobile River further to the east (MDWFP, 2005).

Surface salinity is influenced by the discharge of freshwater from large rivers and is reduced during periods of higher flow in late spring and early summer (Thompson et al., 1999). To assess the potential for water quality effects post-restoration of Ship Island and the closure of Camille Cut, the Engineer Research and Development Center (ERDC) developed a hydrodynamic (CH3D) and water quality model (CEQUAL-ICM) of the study area to evaluate potential changes in circulation and water quality in Mississippi Sound (Appendix D). The impacts are discussed in Section 5.3. Related to existing conditions, the water quality modeling (Appendix D) confirms the trends of lower salinity values in the spring months due to the increased rainfall upstream causing higher flow conditions in the rivers discharging to the Sound. These higher flow rates contribute to lower salinity levels along the coastline during this timeframe. The salinity gradient between bottom and surface waters results from the combination of denser water from outside the Sound moving along the channel toward shore and less dense freshwater remaining at the surface.

During the three benthic macroinfauna community assessments conducted for MsCIP, in June 2010, September 2010, and April/May 2011, water quality samples were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations) (Appendix I). In June 2010, salinity stratification (greater than 3-ppt difference between surface and bottom salinities) was measured at every borrow site station, with average surface salinities ranging from 10–13 ppt and bottom salinities ranging from 17–20 ppt. Salinity stratification was measured at eight placement site locations. During the April/May 2011 event, a less-pronounced salinity stratification was measured at 9 of the 20 borrow site locations. However, at placement site locations, salinity stratification was measured at 13 stations, with several having a significant variation (at least a 10-ppt difference) between surface and bottom salinities (Vittor and Associates, 2013).

At the beach transect locations, salinity measurements were collected at only one depth. Among these locations, salinities measured on the Mississippi Sound side of the barrier islands were lower than those on the Gulf side. In June 2010, salinities varied from 15.8 ppt on the Sound side of Horn Island to 28.5 ppt on the Gulf side. In September 2010, salinities were greater than 20 ppt at all beach transect locations, ranging from 23 ppt at the Cat Island stations (not divided into Sound and Gulf sides) to 32 ppt on the Sound side of Horn Island. During the April/May 2011 event, salinities ranged from 16 ppt at Cat Island and on the Sound side of Horn Island to 25 ppt on the Gulf side of Petit Bois Island (Vittor and Associates, 2013).

Tides across the northeastern portions of the Gulf of Mexico approach the coast from the south and enter the Sound through the passes between the barrier islands, which act as natural barriers to more saline waters. The shipping channels and Camille Cut have allowed higher-salinity water to accumulate in the vicinity of those channels and in the Sound over time.

Seaward of the barrier islands along the continental shelf, salinity patterns are variable due to river and tidal inlet plumes and Loop Current intrusions. The salinity regimes reflect freshwater outflows from the north and west and high-salinity inflows from the open Gulf. Masses of water with different salinities may remain relatively distinct or may mix depending on conditions. Both surface and bottom salinities tend to be lower closer to shore (MMS, 1991). Borrow stations sampled by Vittor and Associates (2013) at locations furthest seaward of the barrier islands (i.e., BSR2, BSR3, BSR4) had higher salinity than other sampling locations, with differences in surface salinities greater than differences in bottom salinities.

4.4.2 Temperature

Data collected from a USGS gauge in Mississippi Sound at East Ship Island between 2007 and 2012 show daily mean temperatures as low as approximately 50°F in the winter and up to 86°F in the summer (10°C to 30°C) (USGS, 2013). Previous studies have identified the annual range in temperature for the Mississippi-Alabama shelf as 62.6-71.6ºF (17º to 22ºC). Temperatures in both deep and shallow water correspond to seasonal variations in air temperature: higher temperatures in the summer months and lower temperatures in the winter months (Thompson et al., 1999). Recent modeling efforts (Appendix D) confirm that temperature patterns increase from the spring through the summer months and eventually begin to decrease in the fall. The State of Mississippi Water Quality Criteria indicate that the maximum water temperature in coastal and estuarine waters shall not exceed 90ºF (32.2ºC) (MDEQ, 2007). MDEQ's 2010 use support report indicates that 97.3 percent of its estuary waters meet the temperature standard (MDEQ, 2010a).

As the distance seaward from the barrier island increases, and depth increases, water temperature becomes less dependent on air temperature. Temperature stratification of the water column may be well developed along the continental shelf by late summer (MMS, 1991). Surface water temperatures offshore average 71.1°F during the winter and 84.4°F during the summer. Bottom temperatures offshore average 57.4°F in the winter and 53.6°F in the summer (MMS, 1991).

4.4.3 Dissolved Oxygen and Hypoxia

Nearshore and open Gulf waters are normally at or near oxygen saturation. However, high organic loading, high bacterial activity related to the decomposition of organic material, and restricted circulation due to stratification of the water column during the summer can cause near-bottom waters to be depleted of oxygen. Oxygen depletion results from the combination of these and other physical and biological processes. In the Gulf of Mexico waters, hypoxia (DO < 2 milligrams per liter [mg/L]) is a common occurrence during the late spring and summer months (Appendix I). USEPA estimates that 4 percent of the bottom waters in the Gulf estuaries have hypoxic conditions or low DO on a continuing basis (USEPA, 2001). Hypoxia affects living resources, biological diversity, and the capacity of aquatic systems to support biological populations. When oxygen levels fall below critical values, those organisms capable of swimming (e.g., fish, crabs, and shrimp) evacuate the area and many bottom-dwelling organisms perish under those conditions. Hypoxic conditions are considered to be hazardous for less or non-mobile macrobenthos (e.g., polychaete worms and burrowing amphipods), with prolonged exposure having the potential to result in deterioration of the benthic community (Appendix I).

During the three benthic macroinfauna community assessments conducted for MsCIP in June 2010, September 2010, and April/May 2011, water quality measurements were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations; on Cat Island, Ship Island, Horn Island, and Petit Bois Island). During the assessment, hypoxic conditions were measured at borrow site stations and placement site stations, with a greater occurrence at the borrow site stations. The beach transect stations generally had the highest DO concentrations. The relatively low occurrence of hypoxic conditions at barrier island placement site locations is likely due to shallow water depths and highly dynamic habitats. The high DO concentrations at beach transect stations, relative to borrow site and placement site locations, is likely due to the high-energy nature of subtidal beach habitats (Appendix I).

From May through June 2010, prolonged hypoxia occurred at the bottom of all borrow site sampling stations. During the June 2010 sampling event, DO concentrations were < 2.0 mg/L at 19 of the 20 stations, and levels were < 0.5 mg/L at 5 stations in the Ship Island Pass and 1 station south of Petit Bois Island. During the same event, hypoxia was measured at 3 of the 25 placement site stations—1 barrier island location and 2 Mississippi Sound locations. It was not determined whether the June 2010 hypoxic conditions were exacerbated by the Deepwater Horizon oil spill or whether DO concentrations were the result of normal seasonal variations. In September 2010, DO levels were > 2.0 mg/L at all MsCIP benthic study locations. During the April/May 2011 sampling event, hypoxic conditions were observed at six borrow site stations: one south of Horn Island and five near or within Petit Bois Pass.

DO in continental shelf waters is normally high. No hypoxic conditions have been recorded in the Mississippi-Alabama continental shelf area (MMS, 1991). During an investigation of the continental shelf conducted from 1987 through 1989, DO levels in bottom water ranged from 2.93 mg/L to 8.99 mg/L, with the lowest summer level being 4.63 mg/L (MMS, 1991). The State of Mississippi Water Quality Criteria require that the DO concentrations be maintained at a daily average of 5.0 mg/L with an instantaneous minimum of not less than 4.0 mg/L (MDEQ, 2007). MDEQ estimates that 99.3 percent of its waters meet the DO standard; all estuarine waters that do not meet the standard are small estuarine embayments rather than waters in the Sound (MDEQ, 2010a).

4.4.4 Turbidity

Turbidity is usually considered a good measure of water quality and is determined by measuring the degree to which the water loses its transparency due to the presence of suspended particulates. The more total suspended solids that occur in the water, the less light penetration and the higher the turbidity.

Various parameters influence the turbidity of the water, including increased sediment levels from erosion or construction activities, suspended sediments from the bottom, waste discharge, algae growth, and urban and agricultural runoff. Suspended sediments enter the Sound from freshwater sources, but are hydraulically restricted due to the barrier islands. The barrier islands, combined with the Sound's shallow depth and mixing from wind, tides, and currents, promote re-suspension of sediments (MDEQ, 2006a). Data available for the USGS station at Ship Island light (USGS Gage 301527088521500) from July to November 2012 showed that turbidity levels were generally less that 20–30 formazin nephelometric units (FNU) with occasional turbidity spikes to as high as 380 FNU (USGS, 2012). Typical turbidity levels in the Sound are relatively high and have been identified as a limiting factor for SAV growth in portions of the Sound (USACE, 2010b, Moncreiff, 2006).

In the continental shelf, schools of demersal animals (those that live or feed near the bottom) may create turbid conditions in bottom waters. Additionally, turbid lenses of brackish water have been observed in surface waters. Offshore of the Mississippi barrier islands, turbidity decreases when clear oceanic waters from the Loop Current intrude into the area. However, these waters are generally more turbid than water off the coast of west Florida. Clear-water layers sometimes occur between turbid surface and bottom turbid layers (MMS, 1991).

MDEQ has a standard for turbidity that is based on the background condition plus 50 nephelometric turbidity units (NTUs) outside a 750-foot mixing zone. MDEQ also grants exemptions to the turbidity standard for environmental restoration projects.

4.4.5 Nutrients

Nutrients are a primary concern in both freshwater and marine ecosystems, providing the building blocks of biological production. Mississippi Sound is a productive estuarine system. MDEQ data (Segrest, personal comm., 2010) show that nitrate concentrations in the project area ranged from 0.005-0.065 mg/L, total phosphorus concentrations ranged from 0.02-0.21 mg/L, and orthophosphate concentrations ranged from 0.002-0.096 mg/L. Nitrogen is generally the limiting nutrient for phytoplankton and algal production in estuarine systems and elevated levels can lead to eutrophication. Data from USEPA for various stations across the Sound (bordered by East Ship Island to the southeast, Deer Island to the northeast, and Henderson Point to the northwest) showed that total nitrogen ranged from 0.33-0.96 mg/L (USEPA, 2012).

Nitrate levels in the OCS tend to be low during the summer months and higher during the winter. Phosphate levels are typically uniformly low year-round (MMS, 1991). Nutrient levels are higher to the west of the project area along the Louisiana-Texas coast where elevated levels of nutrients cause a seasonal hypoxic (low oxygen) zone to develop. High levels of algal and plankton growth associated with elevated nutrient levels followed by bacterial decomposition of organic matter result in DO levels below 2 parts per million (ppm) (USGS, 2013).

4.5 Biological Resources

4.5.1 Coastal Habitats

The Mississippi coast contains a wide diversity of flora and fauna associated with habitats found in coastal Mississippi counties (Hancock, Harrison, and Jackson Counties), as well as Mississippi Sound and the barrier islands. These habitats provide essential services for the plants and animals that live within them, such as physical habitat for many of the species and storm buffering capacity. The Mississippi Sound estuary includes shallow open waters, oyster reefs, tidal pools, mud and sand flats, and river deltas. The barrier islands that lie approximately 6-12 miles offshore include a dynamic and diverse integrated system of beaches, dunes, marshes, bays, maritime forests, tidal flats, and inlets. Natural habitats along the Mississippi coast include many of these same habitat types. Barrier island and Mississippi coastal habitats are described below. In addition, wetland habitats are further discussed in Section 4.5.1.3.

Coastal Mississippi habitats support an array of reptiles, amphibians, birds, and mammals. Reptiles and amphibians found in the area include 23 species of turtles, 10 species of lizards, 39 species of snakes, and the alligator. Eighteen species of salamanders and 22 species of frogs and toads are indigenous to the coastal region. Fifty-seven species of mammals are known to the area and include marsupials, moles and shrews, bats, armadillos, rabbits, rodents, carnivores, even-toed hoofed mammals, and dolphins. Mammals occur within all habitats of the system, using underground burrows, the soil surface, vegetative strata, the air, and the water for feeding, resting, breeding, and bearing and rearing young. Common species of mammals include the raccoon, river otter, gray fox, striped skunk, mink, white-tailed deer, bottlenose dolphin, beaver, opossum, and nine-banded armadillo. Over 300 species of birds have been reported as migratory or permanent residents within the area. Common shorebirds include osprey, great blue heron, great egret, piping plover, red knot (*Calidris canutus*), sandpiper, gulls, brown (and white during migration periods) pelicans, American oystercatcher (*Haematopus palliates*), and terns. Birds of the area eat a great variety of foods, function as food for many predators, and exhibit a diversity of nesting behaviors (USACE 2009a).

4.5.1.1 Barrier Island Beaches

Barrier island beaches consist of two parts, the foreshore, or swash zone, and the backshore. The swash zone includes the area where waves break in moderate weather, and the backshore where waves break during frontal passages, storm surges, and high tides. The beaches consist of well-sorted, fine to coarse sand containing large quantities of quartz and minor amounts of shell and heavy minerals. These shorelines experience erosion and accretion on an ongoing basis, with erosion strongly influenced by tropical storms. Barrier island beaches on northern shores are somewhat protected from waves generated by storms striking from the Gulf of Mexico and are often narrow and more steeply sloped.

Surveys of the mean lower low water (MLLW) and higher high water (MHHW) contours within the potential project footprint identified approximately 34.77 acres of this swash zone/unconsolidated shoreline habitat on the affected barrier islands (Cat Island, Sand Island, and East and West Ship Islands) (see Appendix M).

The backshore is the landward end of the beach where strand lines form and serve as a transition zone to the vegetated landscape. Strand lines are places where sand forms berms and seaborne debris accumulates. Beach vegetation is usually very sparse and confined to the upper edges of the backshore. Sea oats (*Uniola paniculata)*, beach morning glory (*Ipomoea imperati*), and gulf bluestem (*Schizachyrium maritimum*) are the most capable of tolerating the harsh conditions of the backshore. A few animals, such as the ghost crab, amphipods, and various insects, are permanent residents. These beaches provide structural habitat and nutrient and carbon sources that are used by invertebrates, fishes, and wading birds (MDWFP, 2005).

4.5.1.2 Barrier Island Dry Beach and Dune Systems

Dry beach and dune systems on barrier islands consist of zones of well-drained, mostly deep soils composed of windblown sand adjacent to beaches. Some areas are periodically overwashed by storm surges. These habitats contain sparse vegetation, reflecting their exposure to heat, wind, and salt spray. Inland from the dry beach zone and parallel to the shore, swales and dune ridges are present. The dunes, often referred to as “relict dunes,” have a crust of microscopic organisms and can be either stable and firm, with little movement, or semi-stable with some active sand movement. Backbeaches and semi-stable dunes commonly support a sparse cover of a variety of grasses, including gulf bluestem, sea oats, rosette grass (*Dichanthelium* sp.), and dropseed (*Sporobolus* sp.). Common herbs are squareflower (*Paronychia erecta*), pineland scalypink (*Stipulicida setacea)*, Dixie sandmat (*Chamaesyce bombensis)*, and camphorweed (*Pluchea* sp.). The dry meadows are dominated by torpedo grass (*Panicum repens)*, broomsedge bluestem (*Andropogon virginicus*), needlepod rush (*Juncus scirpoides)*, and panic grass (*Panicum* sp.) and contain lesser amounts of saltmeadow cordgrass (*Spartina patens)*. Relict dunes are dominated by shrubby species, including woody goldenrod (*Chrysoma pauciflosculosa)*, prickly pear (*Opuntia* sp.), and saw palmetto (*Serenoa repens)* and occasionally sand live oak (*Quercus geminata)* (Mississippi Museum of Natural Science, 2005). Many shorebirds and waterbirds use these areas for resting and feeding.

Common birds known to frequent these areas include the black skimmer (*Rynchops niger*), black necked stilt (*Hiamantopus mexicanus*), American avocet (*Recurvirostra americana*), laughing gull (*Larus atricilla*), and gull billed tern (*Sterna nilotica*) (Turcotte and Watts, 2009). Bryzoans, a type of floating aquatic colonial animal, are seasonally important and provide both structural habitat and nutrient sources for marine invertebrates, fishes, and wading birds. Common reptiles in these areas include loggerhead sea turtle (*Caretta caretta*) and Mississippi diamondback terrapin (*Malaclemys terrapin pileata*) (Mississippi Museum of Natural Science, 2005).

4.5.1.3 Coastal Wetlands

Coastal wetlands are defined by the Mississippi Coastal Wetlands Protection Act as "all publicly owned lands subject to the ebb and flow of the tide; which are below the watermark of ordinary high tide; all publicly owned accretions above the watermark of ordinary high tide and all publicly owned submerged water-bottoms below the watermark of ordinary high tide"(MS Code 49-27-1-49-27-71 [revised 2003]).These wetlands include tidal marshes, swamps, estuaries, and SAV, which are important as habitat for larval, juvenile, and adult stages and for shoreline protection. On barrier islands, these include interior freshwater wetlands.

The USACE wetland definition is based on the Clean Water Act (CWA). Under that definition, wetlands are areas that are inundated or saturated by surface- or groundwater at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions.

NPS Director's Order #77-1, Wetland Protection, requires the NPS to assign, classify, and inventory wetlands in accordance with the USFWS definition in *Classification of Wetlands and Deepwater Habitats of the United States* (Cowardin et al., 1979). The USFWS defines wetlands as lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water and must have one or more of the following three attributes:

1. At least periodically, the land supports predominantly hydrophytes (wetland vegetation).
2. The substrate is predominantly undrained hydric soil.
3. The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The USFWS's definition includes marine and estuarine intertidal habitats and aquatic habitat areas that, though lacking vegetation and/or soils due to natural, physical, or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life. This broader definition encompasses the intertidal wetland resources affected by the project. These marine habitats are exposed to the waves and currents of the open ocean, and the water regimes are determined primarily by the ebb and flow of oceanic tides (Cowardin et al., 1979).

Since this project is being executed by the USACE, wetlands are determined as defined by the CWA and applicable regulations and policies.

Barrier Island Wet Habitats

Wet habitats on barrier islands include low flats, linear depressions, swales, ponds, and intertidal zones. These habitats occur along the seashore and at slightly higher elevations, often associated with depressions along linear-ridged sand dunes. Wetland communities that form in some wet habitats include freshwater marshes, salt marshes, salt meadows, estuarine shrublands, and slash pine woodlands. They receive freshwater primarily from rainfall and/or saltwater from ocean processes.

Common plants in brackish marsh areas include smooth cordgrass (*Spartina alterniflora*) and black needlerush (*Juncus roemarianus)*. Salt meadow habitats occur at slightly higher elevations above brackish marshes. These are typically dominated by salt meadow cordgrass and torpedo grass. Salt marsh morning glory (*Ipomoea sagittata*), dotted smartweed (*Polygonum punctatum*), umbrellasedge (*Fuirena scirpoidea*), bushy goldentop (*Euthamia leptocephala*), and poorjoe (*Diodia sp*.) are common forbs.

Estuarine shrublands typically contain eastern baccharis (*Baccharis halimifolia*), southern bayberry (*Morella caroliniensis*), and yaupon (*Ilex vomitoria*) with salt marsh cordgrass and torpedo grass forming ground cover within these shrublands. Island pinelands are found on low flats, along pond shores, and within swales of the linear dune systems. These pinelands consist of dense to open stands of slash pine (*Pinus elliottii*) as well as shrubs such as yaupon, saw palmetto, southern bayberry and occasionally, sand live oak (MDWFP, 2005; USACE, 2009a).

The total wetlands area on Sand Island encompasses 45.48 acres, 23.49 of which are internal wetlands and 21.99 of which are marine intertidal, including the marine intertidal beach. These wetlands were delineated under the NPS classification system and according to Procedural Manual #77-1 (NPS, 2012). These wetlands were formed on the west-central part of the island between 2001 and 2013 as the result of disposal activities associated with maintenance of the Pascagoula Federal navigation project within this area of DA-10 (Figure 4-2). Additionally, approximately 36.77 acres of existing intertidal wetlands were identified on Cat Island (2.52 acres) and East and West Ship Islands (21.75 acres). Sand placement on these islands would result in long-term beneficial impact to biological resources through the creation of new island habitat, as will be discussed in Section 5.

Tidal Marshes, Swamps, and Bayous

Coastal wetlands, such as freshwater and tidal or salt marshes, swamps, and bayous, are found in the project area along the Mississippi coast, estuaries, and tidal inlets. Freshwater marshes are often tidally influenced, with varying elevations and functioning buffers, and are dominated by grasses. Freshwater flows through the marshes are necessary to limit saltwater intrusion. These freshwater flows also maintain suitable habitat for many species of marine flora and fauna that begin their lives in the marsh, as well as foraging, breeding, and nesting areas. Salt marshes in the area are tidally influenced and are characterized by their low position within the tidal zone, increased exposure to higher water salinities, and increasing salinity in the soils. They often have functioning buffers and marsh zonation. Black needlerush is often the dominant plant species in the salt marshes of the area. Salt pannes or flats are salt marsh areas with highly saline soils and salt marsh vegetation, typically short halophytic plants including saltwort (*Batis maritima*), glasswort (*Salicornia* spp.), seepweed (*Suaeda* spp.), and saltgrass (*Distichlis spicata*). Where salinity is extremely high, the pannes become barren (MDWFP, 2005). Coastal Mississippi swamps and bayous are regularly flooded, forested habitats dominated by bald cypress (*Taxodium distichum*) and pond cypress (*Taxodium ascendens*). Swamps and bayous are important habitat for many species of reptiles, insects, mammals, birds, amphibians, finfish, and shellfish.

The project area is bordered by two large marsh systems along the Mississippi mainland coast. The Grand Bay Marshes to the east lies within the 18,000-acre Grand Bay National Estuarine Research Reserve (NERR) in Jackson County (USACE, 2009a). The Grand Bay NERR was established in 1999 and is managed through a unique local, state, and federal partnership designed to promote estuarine research and education within Mississippi's Coastal Zone and its adjacent ecosystems. In addition, the Grand Bay National Wildlife Refuge is located in Jackson County. It was established in 1992 under the Emergency Wetlands Resources Act of 1986 and is managed by the USFWS to protect one of the largest expanses of undisturbed pine savanna habitats in the Gulf Coastal Plain region. The Hancock County Marshes to the west, at 13,570 acres, is the second largest continuous marsh area in Mississippi, extending from the Pearl River to Point Clear.

4.5.1.4 Submerged Aquatic Vegetation

SAV in the project area includes various types of seagrass. Historical studies have identified varying areas of SAV in Mississippi Sound ranging from a high of approximately 13,000 acres in 1969 to around 2,000 acres in 1999 (Moncreiff, 2006). Approximately 2,000 acres of seagrass beds were identified along coastal Mississippi in 2005 (MDWFP, 2005). Within the project area, SAV is found primarily along the northern shores of the barrier islands and in small patches throughout the immediate shorelines. These areas are characterized by shoal grass (*Halodule wrightii*), manatee grass (*Cymodocea manatorum*), turtle grass (*Thalassia testudinum*), and widgeon grass (*Ruppia maritime*) (USACE, 2009a).

Suitable habitat for seagrass is determined by the depth and clarity of the water, sediment characteristics, salinity, and wave energy. It is estimated that 50–90 percent of all marine species utilize SAV at some point in their life cycle (Moncreiff et al., 1998). SAV provides spawning, nursery, refuge, and feeding areas for many species in the project area, including shrimp, crabs, scallops, redfish, speckled trout, and mullet.

The health, continued survival, and future growth of many SAV areas have been threatened by natural processes, such as disease, fluctuations in salinity, declining water quality, and storm events, as well as anthropogenic activities. There are also significant seasonal and annual variations in SAV abundance and species composition (Cho and May, 2006). As more stable, climax seagrasses such as turtle grass and manatee grass have declined, the relative abundance of opportunistic, pioneer species such as widgeon grass and shoal grass in estuaries and along barrier islands of the northern Gulf of Mexico has increased. These changes accentuate the temporal and spatial fluctuations of SAV because areal coverage and distribution of both widgeon grass and shoal grass change substantially from season to season and year to year (Cho and May, 2006).

Decreases in seagrass in the project area have been documented between 1969 and 1992. Horn Island has seen a decrease of approximately 5,000 acres during this period, with Cat Island, East Ship Island and West Ship Island, and Petit Bois Island losing approximately 430 acres, 1,280 acres, and 1,300 acres, respectively (USACE, 2009a). A 1999 survey estimated remaining SAV and seagrasses at approximately 1,594 acres around Cat Island, 242 acres around East Ship Island and West Ship Island, 578 acres around Horn Island, and 425 acres around Petit Bois Island (Handley et al., 2007). Because Mississippi Sound's seagrasses and other SAV provide critical habitat for recreational and commercial marine species, The Nature Conservancy has named the area a priority conservation area on the Gulf Coast. Threats to this area include increased inshore fishing pressure, recreational boating, increased turbidity from incompatible development, and nutrient runoff (Beck et al., 2000).

As part of this SEIS, SAV within the project area was surveyed in July 2010 (Vittor and Associates, 2011). Overall, 3,614 acres of SAV were mapped around the barrier islands. Surveyed areas of SAV consisted of shoal grass at all locations. Vegetated bed densities were mostly patchy (<50 percent coverage) (Appendix H) with the largest SAV areas mapped near Cat Island. Table 4-1 shows SAV acreage by Barrier island. Figures 4-3 and 4-4 show SAV locations on Cat and East and West Ship Islands, respectively.

TABLE 4-1
SAV Acreage—July 2010

Location	Density	Acreage
Cat Island	Continuous	178
	Patchy	1,534
West Ship Island	Patchy	261
East Ship Island	Patchy	125
Horn Island	Patchy	974
Petit Bois Island	Patchy	541

Source: Vittor and Associates, 2013

4.5.1.5 Shrublands

Estuarine shrublands follow the shoreline of marshes and adjoin upland areas along intertidal marsh fringes and on small islands. Common vegetation in these areas includes eastern baccharis and southern bayberry (Mississippi Museum of Natural Science, 2005). Many of the same birds that are found in the beach and dune habitat are found in shrublands.

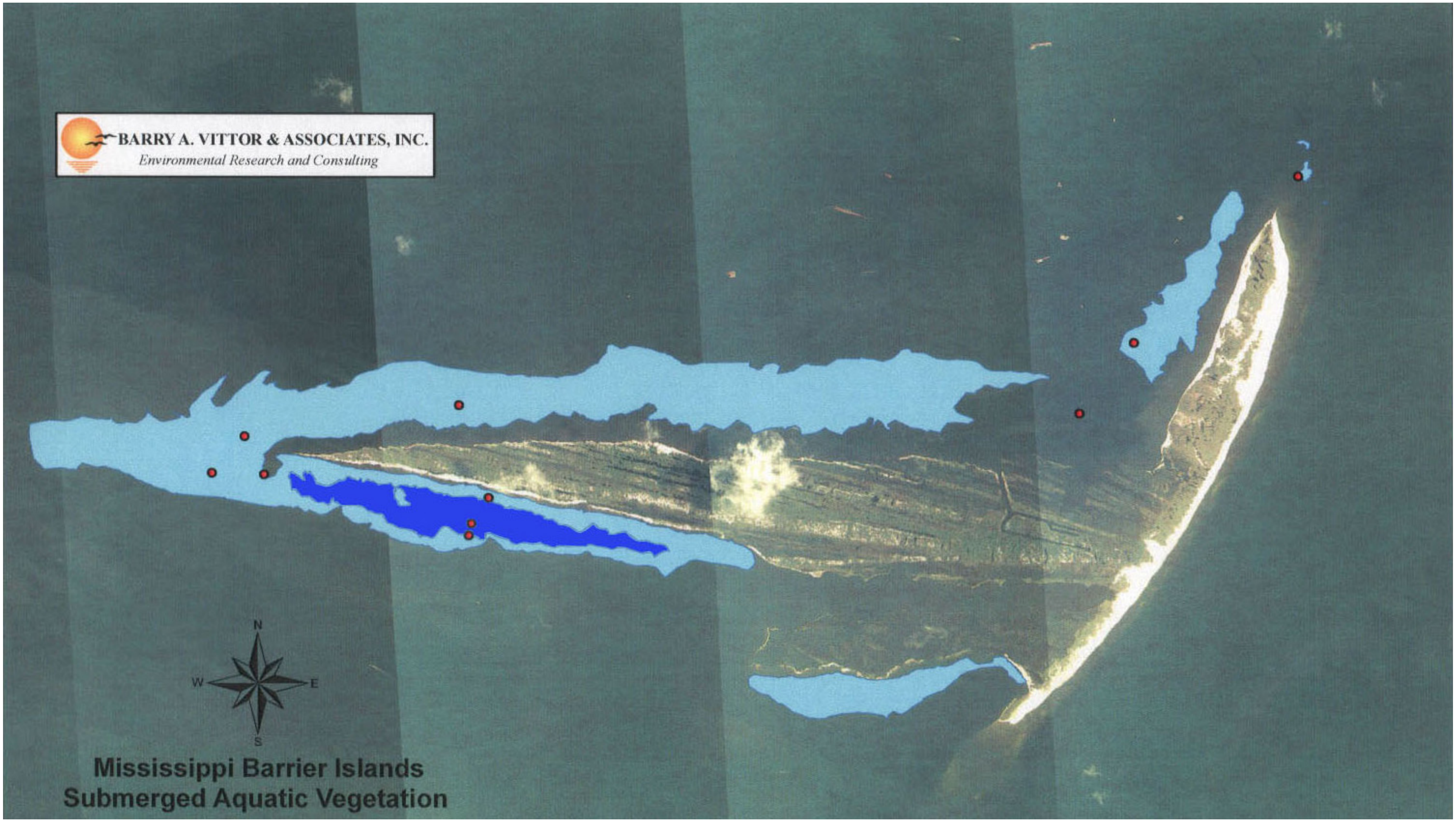
4.5.1.6 Coastal Flatwood and Maritime Forests

The coastal forests of Mississippi include upland and wetland slash pine flatwood/savanna communities that occupy ancient low shoreline beach ridges and low flats situated immediately inland from tidal marshes. They are also found along terrace levees of tidal creeks. Slash pine and the understory species found in the forests can tolerate seasonally wet or saturated soils, including saturation due to periodic storm surges of brackish water. Adjacent to the coast, saltmeadow cordgrass dominates the understory. Saltmeadow cordgrass is no longer dominant a short distance inland, but occasionally the species persists several miles inland along creeks and bayous. Common shrubs in the community include southern bayberry, eastern baccharis, and yaupon. Coastal flatwood forests are fire-dependent and can become brushy during long intervals between burns (MDWFP, 2005).

Coastal live oak woodlands are another maritime forest community found along both the Mississippi coast and on barrier islands. Live oak woodlands are found on coastal cheniers and ancient beach ridges that straddle the coast line. These woodlands are dominated by live oaks and upland laurel oaks (*Quercus hemisphaerica*) and typically contain an understory of saw palmetto. These forests and coastal flatwood forests provide important stop-over locations for neotropical migrants during spring and fall migrations (MDWFP, 2005).

4.5.1.7 Mississippi Mainland Beaches

The majority of the shoreline in coastal Mississippi consists of man-made beaches waterward of concrete seawalls. These beaches are often located in areas that were historically marshes. These beaches were frequently built to reduce risk of storm damage to the roadways and seawalls and also to provide recreation and aesthetic benefits. The marsh habitat was destroyed or eliminated along with its associated storm surge protection (USACE, 2009a).



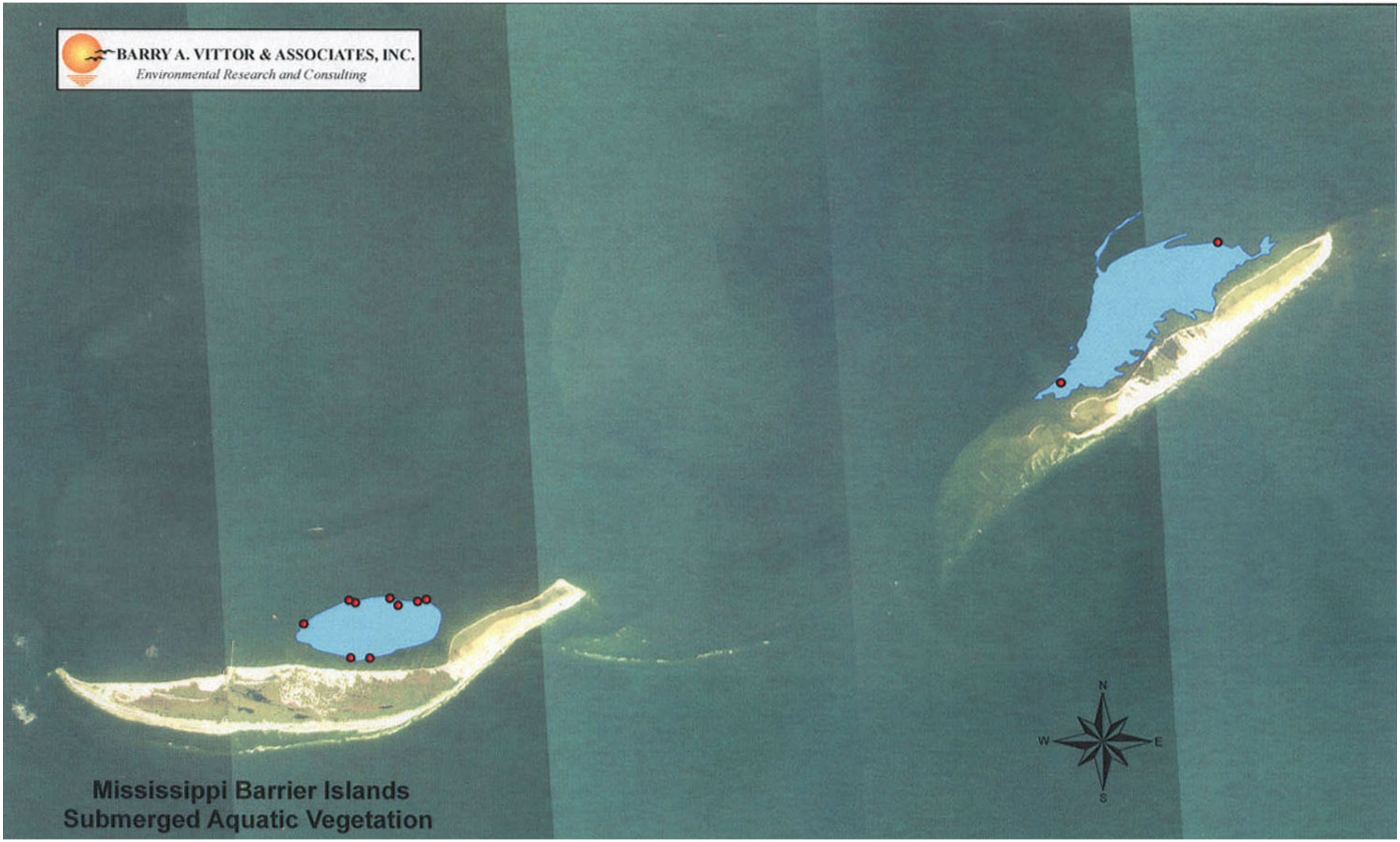
Patch SAV (~1,534 Acres)
Continous SAV (~178 Acres)
Field Survey Locations

N

0 2,000 4,000 8,000 Feet

FIGURE 4-3
CAT ISLAND SUBMERGED AQUATIC VEGETATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV MsCIP 2/26/2014 lk/dk



Patch SAV (~387 Acres)
Field Survey Locations

N

0 2,000 4,000 8,000 Feet

FIGURE 4-4
WEST AND EAST SHIP ISLAND SUBMERGED AQUATIC VEGETATION LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES041513031852KNV MsCIP 2/26/2014 lk/dk

Some natural beaches occur along the mainland coast. These are predominantly found at the mouths of rivers, such as the Pearl and Pascagoula Rivers. These beaches often have substrates that are muddy in texture because they originate from the eroding intertidal marshes. However, a few significant segments of sand or shell beach exist along the mainland, such as along the Rigolets Islands on the borders of Mississippi and Louisiana, Pointe-aux-Chenes, southwest of the mouth of Graveline Bayou, southeast of the mouth of Davis Bayou in Jackson County, on Big Island in Back Bay of Biloxi in Harrison County, and between the mouth of Bayou Caddy and Landmark Bayou in Hancock County. These beaches serve as important nesting habitat for the Mississippi diamondback terrapin.

In addition to natural beaches and sandy shores, mud and sandy mud shores occur along tidal streams and mud flats occur within the coastal estuaries. Mud shores and mud flats harbor numerous microorganisms, such as phytoplankton, fungi, bacteria, and protozoans that serve as an important food source for benthic invertebrates (polychaetes, mollusks, and crustaceans), which in turn support mid- and upper level consumers such as crabs, shorebirds, shrimp, and fish. Wading and shorebirds are especially dependent on mud shores. Herons, egrets, sandpipers, plovers, godwits, willets, terns, gulls, ducks, and osprey frequent this habitat (MDWFP, 2005).

4.5.2 Plankton

4.5.2.1 Plankton and Algae

Phytoplankton and Filamentous Algae

Diatoms and dinoflagellates are the dominant components of the phytoplankton community in the Gulf of Mexico, and the relative composition of these organisms depends on nutrient and silica availability in the water. Over 900 diatom species and 400 dinoflagellate species have been reported from the Gulf of Mexico.

Within Mississippi Sound, phytoplankton communities are generally quite diverse, with occasional monotypic blooms. Salinity, nutrient concentrations, temperature, and wind conditions influence the distribution of phytoplankton. Population composition, abundance, and diversity also vary by season. Seventy-seven species of marine algae have been identified as part of the summer flora of Mississippi Sound, though more species are likely present (Eleuterius, 1981). The greatest diversity of phytoplankton has been reported in areas affected by river discharges where both riverine and marine species occur (USEPA, 1991).

Blue-green algae and diatoms are the dominant microflora in marshes and seagrass beds in Mississippi Sound (Stout and de la Cruz, 1981; Daehnick et al., 1992). Red algae are the dominant filamentous algae in those systems and support coverings of epibenthic diatoms. Phytoplankton production in seagrass beds is highest in summer (August) and lowest in winter (January) (Moncreiff et al., 1992). Chlorophyll *a* concentrations in seagrass beds have been measured in a range of 14 milligrams per square meter (mg/m^2) to 125 mg/m^2, but average 26–86 mg/m^2 depending on season and water conditions (Daehnick et al., 1992).

Seaward of the barrier islands along the shelf, both estuarine and Gulf species of plankton are present. Populations are greatest during the winter and spring and lowest during the late summer and fall. Surface chlorophyll *a* concentrations range from 0.04-1.73 mg/m^2 and average 0.69 mg/m^2. This value is about three times those of the open Gulf (MMS, 1991).

Zooplankton

Median zooplankton biomass has been measured on the continental shelf at 10.1 cubic centimeters per liter (USEPA 1991). Copepods are typically the dominant zooplankton form in this environment. In the mid-shelf region south of Mississippi, the copepod genus *Paracalanus* has been reported in concentrations of 3,036 individuals per cubic meter. Relatively high zooplankton abundance has been reported within the passes of the barrier islands (USEPA, 1991).

The zooplankton community seaward of the barrier islands is composed of estuarine and open Gulf species and, thus, exhibits high diversity. Zooplankton volumes are greatest nearshore and tend to decrease with distance from shore. Seasonal changes in species composition and abundance are also evident, with zooplankton most abundant in the winter and high during the summer, and less abundant in the fall. Surface zooplankton volumes average 80–108 individuals per milliliter in waters shallower than 40 meters (MMS, 1991). Ichthyoplankton are an important component of the zooplankton community and are addressed in Section 4.5.4.

Harmful Algal Blooms

"Harmful algal bloom" (HAB) refers to a phytoplankton bloom producing toxins that cause harmful conditions. A small number of phytoplankton species produce neurotoxins. These toxins can be transferred through the food web where they affect higher forms of life such as zooplankton, shellfish, fish, birds, marine mammals, and humans that feed either directly or indirectly on them.

The source of HABs is not clear. Such blooms have occurred in waters where pollution is not an obvious factor, although an increase in nutrients stimulates algal blooms. The presence of toxic species is a natural occurrence that can be exacerbated by natural currents and environmental forces (e.g., hurricanes). The recent identification of a higher number of bloom events may reflect better detection methods and an increase in the number of observers (Anderson, 2010). Two species of algae (*Alexandrium monilata* and *Karenia breivs*) have caused HABs near the Mississippi coast. The species *K. breivs* causes neurotoxic shellfish poisoning; previous blooms have affected scallops, surfclams, oysters, southern quahogs, coquinas, tunicates, commercial and recreational species of fish, sea birds, sea turtles, manatees, and dolphins. Blooms of *A. monilata* have impacted oysters, coquinas, mussels, gastropods, and fish (Anderson, 2010).

4.5.3 Benthic Environment

4.5.3.1 Benthic Invertebrates

The bottom sediments in Mississippi Sound provide habitat for multiple species of infaunal and epifaunal invertebrates. Due to the frequent disturbances in the area (e.g. sediment disposal, storm action, and maritime activity), species present tend to be either tolerant of disruption or capable of rapidly re-colonizing disturbed areas.

The two most comprehensive historical studies of benthic habitats in the project area include the "Benthic Macroinfauna Community Characterizations in the Mississippi Sound and Adjacent Areas" study (MSAAS) (USACE, 1982) and studies conducted by Rakocinski and colleagues in the 1990s (Rakocinski et al., 1991, Rakocinski et al., 1993, Rakocinski et al., 1998). The MSAAS involved sampling habitats in Mississippi Sound and in shallow water

(10–50 feet) in the Gulf of Mexico, while the Rakocinski studies focused on Mississippi barrier island beaches. Together, these studies provide a historical account of "typical" macroinvertebrate assemblages in the following habitat types: shallow Sound, tidal pass, offshore barrier island, offshore shallow water, and barrier island beach.

In the 1982 study, over 532 taxa from offshore Mississippi and Alabama and 437 taxa from Mississippi Sound were identified. Densities of individuals varied from 910–19,536 individuals per square meter for the offshore and 1,200 and 38,863 individuals per square meter for the Sound area (USACE, 2009a).

In a 1980 comprehensive benthic invertebrate study, Vittor identified 330 infauna taxa, with a single polychaete (*Myriochele oculata*) comprising over 40 percent of all organisms encountered during the survey (over 198,000 specimens). Three other polychaetes, *Mediomastus* ssp., *Paraprionospio pinnata,* and *Owenia fusiformis,* represented over 13 percent of the community (Vittor, 1981). Other common benthic invertebrates in Mississippi Sound include bivalves, gastropods, malacostracans, and nemertean worms (MDEQ, 2006b).

A 3-year (1987—1989) evaluation of the benthic community seaward of the barrier islands determined that the benthic macroinfauna were dominated by polychaete species, which represented about 60 percent of the community. Mollusks and crustaceans each constituted approximately 15 percent, with the remaining 10 percent of the community consisting of more than 12 different phyla. Macroinfaunal density was closely related to the sediment type. Highest densities occurred in areas with coarse sediments of sand and shell and lowest densities appeared in the sediments consisting of silt and clay (MMS, 1991).

During the three benthic macroinfauna community assessments conducted for MsCIP in June 2010, September 2010, and April/May 2011, benthic macroinfauna samples were collected from 20 offshore locations (borrow site stations), 19 beach/subtidal locations (beach transect stations), and 25 sand placement locations (placement site stations) (Figure 4-5). The offshore locations were selected within each potential borrow area to be representative of conditions in each of the potential borrow areas and included littoral shoal/disposal habitats (e.g., DA-10/Sand Island and Petit Bois Pass) and fluvial/ebb-tide delta habitats (Ship Island and Cat Island Pass borrow areas). The beach/subtidal locations on the Mississippi Sound and Gulf of Mexico sides of the barrier islands were representative of potential island restoration placement areas (e.g., Cat Island). The sand placement locations were close to the islands and were representative of MsCIP sand placement alternatives, including shallower, shoreline habitat along the barrier islands and within Camille Cut. The results of the study (Vittor and Associates, 2013) are included as Appendix I and summarized below. When applicable, comparisons to historical studies are also provided.

4.5.3.1.1 Borrow Site Stations

Table 4-2 summarizes the dominant taxa at borrow site stations in Mississippi Sound, near the barrier islands, and at offshore locations south of the barrier islands during the MsCIP benthic macroinfauna study and those at comparable historical sampling stations.

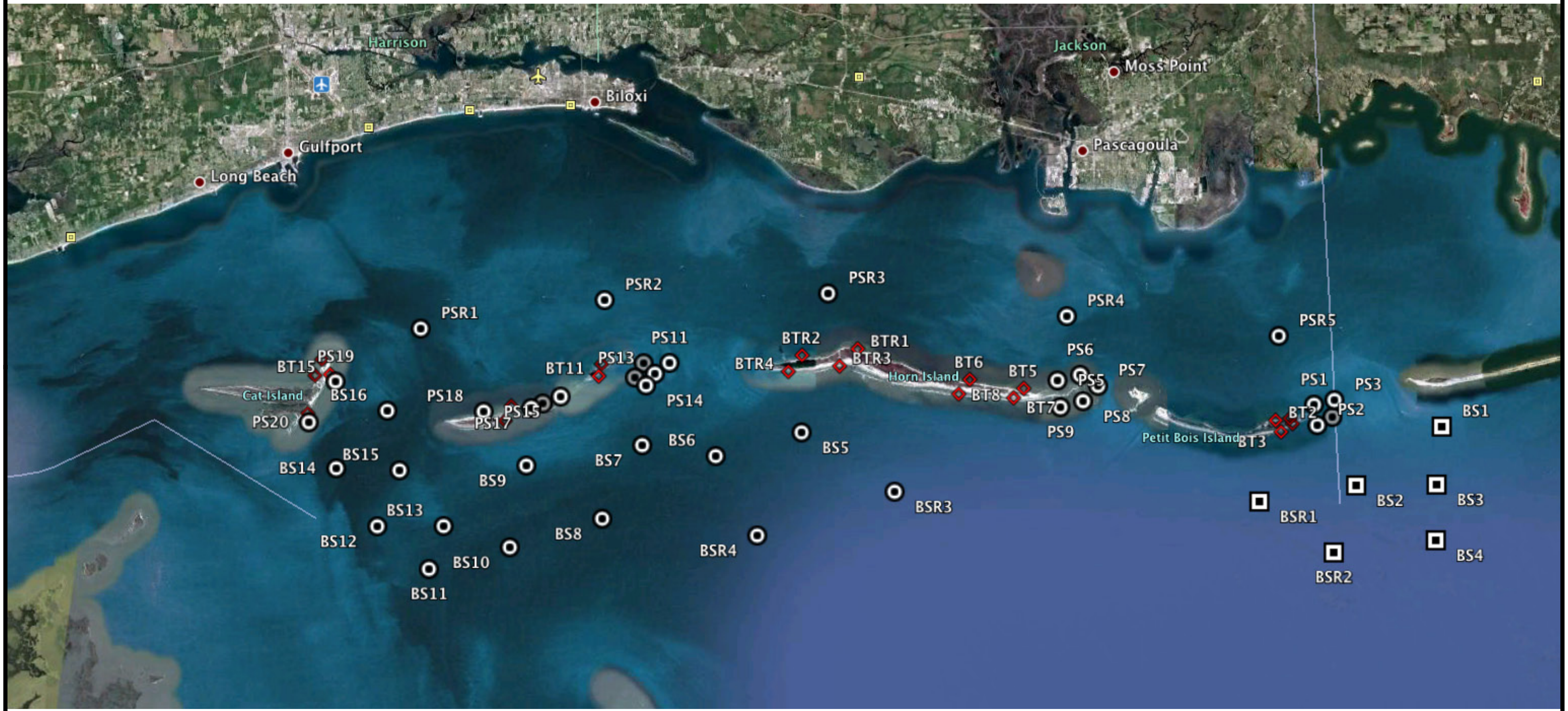


FIGURE 4-5
STATION LOCATIONS FOR THE BENTHIC MACROINFAUNAL COMMUNITY ASSESSMENT, 2010-2011
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

ES121410141439ATL

TABLE 4-2
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Borrow Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Average Taxa Richness[a]	Average Density[b] (number/square meter)
East Borrow Sites (Vittor and Associates, 2013)	June 2010	Polychaete assemblage (*Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackerae)*	23	2,000
	September 2010	Polychaete assemblage (*P. pinnata, M. uebelackerae)* and chordate *Branchiostoma* spp.	13	600
	April/May 2011	Mixed polychaete/crustacean assemblage Polychaetes (*Meredithia uebelackerae, Mediomastus* spp., and *Sigambra tentaculata)*	25	1,600
West Borrow Sites (Vittor and Associates, 2013)	June 2010	Polychaete assemblage (*Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackerae)*	15	1,700
	September 2010	Polychaete assemblage *(P. pinnata, M. uebelackerae*) and chordate *Branchiostoma* spp.	7.5	500
	April/May 2011	Mixed polychaete/bivalve assemblage Polychaetes (*Meredithia uebelackerae, Mediomastus* spp., and *Sigambra tentaculata)*	10.5	1,400
MSAAS Offshore Locations (USACE, 1982)	Fall 1980	Surface and subsurface deposit feeding polychaetes (*Magelona* cf. *phyllisae*, *Mediomastus* spp. and *Galathowenia oculata)*	N/A	N/A
	Spring 1981	Surface and subsurface deposit feeding polychaetes (*M. phyllisae* and *Mediomastus* spp.)	N/A	N/A
Inner Subtidal Zone (depths < 2 meters) (Rakocinski et al., 1991; Rakocinski et al., 1993)	1993	Polychaetes (*Paraonis, Leitoscoloplos*), crustaceans (haustorid amphipods), and bivalves (*Donax*)	N/A	N/A
Mississippi-Alabama Continental Shelf (MMS, 1991)	1987–1989	Polychaetes (approximately 60%), mollusks (15%), and crustaceans (15%) over 12 different phyla (10%)	N/A	N/A

N/A = not available
[a] Taxa richness is a measure of the number of different taxa present in the ecological community.
[b] Taxa density is a measure of how abundant the taxa are within the sample.

During the MsCIP study, a polychaete assemblage dominated the benthos at borrow site stations in June 2010 and September 2010. In April and May 2011, a mixed polychaete/crustacean assemblage dominated the six most eastern borrow site stations off the eastern tip of Petit Bois and the western tip of Dauphin Island, and a polychaete/bivalve assemblage dominated the 14 borrow site stations to the west, off of Horn, East Ship, West Ship, and Cat Islands (Table 4-2). The polychaetes, *Paraprionospio pinnata, Mediomastus* spp., *Meredithia uebelackera*, and the chordate, *Branchiostoma* spp., dominated both the east and west borrow sites in June and September 2010. The polychaetes, *M. uebelackerae, Mediomastus* spp., and *Sigambra tentaculata,* dominated the borrow sites during the April/May 2011 event. The macroinvertebrate assemblages found at borrow site stations were generally similar to those collected at offshore locations in 1980–81 for the MSAAS (USACE, 1982), as well as those collected by Rakocinski et al. (1993) in the inner subtidal zone, ranging between the island shore and 100 meters from the shore. Additional detail on the studies conducted for MsCIP is in Appendix I.

Macroinvertebrate taxa richness and densities at the borrow site stations during the MsCIP study exhibited significant variation between events and locations (Table 4-2). Taxa densities and richness were higher at the east borrow site stations than at the west borrow site stations during each of the three sampling events. Seasonal variations, including a decrease in taxa richness and macroinvertebrate densities during September 2010 may be partially attributable to one or both of two events: (1) the Deepwater Horizon oil spill, in April 2010, in which the Mississippi barrier islands and adjacent waters received surface and subsurface petrochemicals and dispersant chemicals; and (2) a prolonged hypoxic event at all borrow site stations in May-June 2011. Taxa richness at the east borrow site stations decreased significantly from June 2010 to September 2010, but taxa richness recovered to June 2010 levels by the April/May 2011 sampling event. Taxa richness at the west borrow site stations similarly decreased from June 2010 to September 2010. Macroinvertebrate densities at both the east and west borrow site stations decreased significantly from June 2010 to September 2010, and densities only partially recovered by April/May 2011.

4.5.3.1.2 Placement Site Stations

Table 4-3 summarizes the dominant taxa at placement site stations during the MsCIP benthic macroinfauna study and those at comparable historical sampling stations. The placement site stations were primarily dominated by polychaetes (e.g., *Spiophanes, Polygordius, Magelona, Meredithia, Mediomastus, Paraonis, Paraprionospio),* bivalves *(Gemma gemma),* arthropods (*Pinnixa),* chordates (*Branchiostoma),* and amphipods (*Acanthohaustorius).* Camille Cut was the only location that was dominated almost entirely by bivalves, though the polychaete *Paraonis* was also dominant during the April/May 2011 event. The Mississippi Sound stations were the only sites dominated by gastropods (*Nuculana, Nassarius*) in addition to polychaetes.

Among the placement site stations, taxa richness and macroinfaunal densities varied by location. Taxa richness at the five Mississippi Sound stations was significantly lower than that at the barrier island locations. Habitat at the Mississippi Sound stations differed from other placement site stations due to deeper water and silty, clay sediment. The sediment at other placement site stations was comprised of clean sand. Macroinfaunal densities at the three Camille Cut stations were significantly higher than those at the other barrier island locations and the Mississippi Sound locations.

TABLE 4-3
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Placement Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Approximate Average Taxa Richness	Approximate Average Density (number/ square meter)
Petit Bois Island	June 2010	Polychaete, *Spiophanes;* arthropod, *Pinnixa;* bivalve, *Gemma*	27.5	3,500
	September 2010	Bivalve*, G. gemma;* chordate, *Branchiostoma*	12.5	5,100
	April/May 2011	Polychaete, *Polygordius;* bivalve, *G. Gemma*	22.5	5,000
Horn Island	June 2010	Polychaetes, *Polygordius* and *Magelona*; bivalve, *G. gemma;* chordate, *Branchiostoma*	17.5	4,000
	September 2010	Bivalve*, G. gemma;* chordate, *Branchiostoma*	11.0	900
	April/May 2011	Polychaetes, *Polygordius*; bivalve, *G. gemma*	25.0	11,000
Ship Island	June 2010	Polychaetes, *Magelona* and *Meredithia;* amphipod, *Acanthohaustorius*; bivalve, *G. gemma*	16.5	4,700
	September 2010	Polychaetes (*Mediomastus, Paraonis, Magelona*)*;* chordate, *Branchiostoma*	16.0	1,800
	April/May 2011	Polychaetes (*Mediomastus, Spiophanes*); haustorid amphipod assemblage	21.0	2,700
Camille Cut	June 2010	Bivalve, *G. gemma* (> 70% of the assemblage)	12.5	9,000
	September 2010	Bivalve, *G. gemma* (> 85% of the assemblage)	13.0	30,000
	April/May 2011	Bivalve, *G. gemma;* polychaete, *Paraonis*	15.0	13,000
Cat Island	June 2010	Polychaete, *Mediomastus;* amphipod, *Acanthohaustorius*	25.5	3,500
	September 2010	Cirratulid polychaete, *Mediomastus; Branchiostoma*	10.0	750
	April/May 2011	Polychaetes, *Mediomastus* and *Meredithia*	28.0	4,000
Mississippi Sound	June 2010	Polychaete complex (*Mediomastus, Paraprionospio*) and gastropods (*Nuculana, Nassarius*)	16.0	1,100
	September 2010	Polychaete complex (*Mediomastus, Paraprionospio*) and gastropods (*Nuculana, Nassarius*)	7.5	500
	April/May 2011	Polychaete, *Mediomastus*	20.0	1,600

TABLE 4-3
Summary of Dominant Taxa, Taxa Richness, and Densities at MsCIP Benthic Macroinfauna Study Placement Sites and Dominant Taxa at Comparable Historical Sampling Sites

Location	Sampling Season	Dominant Taxa	Approximate Average Taxa Richness	Approximate Average Density (number/ square meter)
MSAAS Shallow Sound Sand (USACE, 1982)	Fall 1980/ Spring 1981	Bivalve, *G. gemma*; polychaete, *Paraonis;* amphipod, *Lepidactylus* (these same taxa were dominant components of the barrier island macroinvertebrate assemblages seen in Vittor and Associates, 2013)	N/A	N/A
MSAAS Inshore Sound (USACE, 1982)	Fall 1980/ Spring 1981	Polychaetes, *Galathowenia* and *Owenia;* haustorid amphipods	N/A	N/A
MSAAS Tidal Pass (USACE, 1982)	Fall 1980/ Spring 1981	Surface and subsurface deposit feeders (e.g. polychaetes, *Polygordius and Spiophanes*; chordate, *Branchiostoma*; haustorid amphipods; suspension feeding bivalves)	N/A	N/A
Inner Subtidal (Rakocinski et al., 1993)	1993	Polychaetes (*Paraonis)*; haustorid amphipods; bivalves (similar to assemblages associated with the barrier islands in Vittor and Associates, 2013)	N/A	N/A
Shallow Subtidal (Rakocinski et al., 1991)	1991	Polychaetes (*Paraonis, syllids*); chordate, *Branchiostoma*; amphipod (*Lepidactylus*)	N/A	N/A

N/A—Not Available

The macroinvertebrate assemblages at placement site stations varied significantly between locations and among seasonal events (Table 4-3). Significant declines in taxa richness between June 2010 and September 2010, as well as recovery by April/May 2011, were observed at Petit Bois Island, Horn Island, and the Mississippi Sound stations. Macroinvertebrate densities significantly declined between June 2010 and September 2010 at stations on Horn Island, Ship Island, Cat Island, and Mississippi Sound locations, with recovery occurring by April/May 2011 on Horn Island, Cat Island, and Mississippi Sound. Densities at Ship Island stations only partially recovered to June 2010 levels by the April/ May 2011 event. Unlike at the borrow site stations, hypoxic conditions were infrequent at the placement site locations (only measured at three locations in June 2010), likely due to shallow water depths and highly dynamic habitats.

Historical sampling locations representative of the MsCIP placement site stations include the MSAAS shallow Sound, inshore Sound, and tidal pass locations and Rakocinski's inner subtidal and shallow subtidal locations. Macroinvertebrate assemblages in the MSAAS shallow Sound sand habitat were similar to those observed at the barrier island placement site stations. The MSAAS Tidal Pass and the MsCIP Camille Cut assemblages were comparable, dominated by surface and subsurface deposit feeders. Macroinvertebrate assemblages in Rakocinski et al. (1993) inner subtidal and shallow subtidal habitats were similar to those at the barrier island placement site stations. At the Mississippi Sound locations, the macroinvertebrate assemblages were dominated by polychaetes (*Mediomastus,* *Paraprionospio*) and gastropods (*Nuculana, Nassarius*) in June and September 2010 and by *Mediomastus* in April/May 2010. These assemblages were similar to those observed in the MSAAS's Inshore Sound stations in 1980 and 1981 (USACE, 1982).

4.5.3.1.3 Beach Transect Stations

Taxa richness and density data collected from beach transect stations at depths of 10, 20 and 50 feet had low taxa richness (relative to the borrow site and placement site stations) and variable densities (Tables 4-4 and 4-5). Beach transect station samples contained patchy distributions of several habitat-specific macroinvertebrate taxa, and there were no apparent seasonal trends. Dominant taxa varied by depth as follows:

- Shallow (10-foot) stations were dominated by oligochaetes, bivalves, amphipods, cumaceans, isopods, and polychaetes.
- Mid-depth (20-foot) stations were dominated by oligochaetes, amphipods, mysids, cumaceans, a pinnotherid crab, bivalves, and polychaetes.
- Deep stations (50-foot) stations were dominated by polychaetes, bivalves, amphipods, isopod, and a cumacean.

TABLE 4-4
Summary of Dominant Taxa, Taxa Richness, and Density at Shallow, Mid-depth, and Deep Beach Transect Stations

Location	Dominant Taxa	Average Taxa Richness [a,b]	Average Density (number/square meter) [a,b]
Gulf Shallow (10-feet) Stations (n = 8)	All Shallow Stations: Oligochaetes; bivalves, *Gemma* and *Donax variabilis;* amphipod, *Lepidactylus triarticulatus;* cumacean, *Spilocuma;* isopod, *Exosphaeroma;* polychaete, *Paraonis fulgens*	1.5–3.5	500–4,000
Miss. Sound Shallow Stations (n = 8)		5–11.5	5,200–34,000
Gulf Mid-depth (20-feet) Stations (n = 8)	All Mid-depth Stations; Oligochaetes; amphipods, *Lepidactylus* and *Haustorius*; mysid, *Metamysidopsis;* cumacean, *Spilocuma;* pinnotherid crab, *Pinnixa;* bivalves, *G. gemma* and *D. variabilis;* polychaetes, *Paraonis*, *Leitoscoloplos*, *Sphaerosyllis* and *Nereis*	2–5	900–3,000
Miss. Sound Mid-depth Stations (n = 8)		5.5–15	8,500–45,000
Gulf Deep (50-feet) Stations (n = 8)	All Deep stations: Polychaetes, *Paraprionosyllus*, *Sphaerosyllis*, *Leitoscoloplos*, *Capitella* and *Paraonis;* bivalves, *G. gemma* and *D. variabilis;* amphipods, *Lepidactylus* and *Acanthohaustorius;* isopod, *Ancinus*, and the cumacean, *Spilocuma*	2.5–6	1,000–3,600
Miss. Sound Deep Stations (n = 8)		6–14.5	7,200–48,000

[a] Does not include Cat Island stations, which were not separated into Sound side/Gulf side groupings
[b] Range among locations (5) and events (3)

TABLE 4-5
Summary of Taxa Richness and Density at Beach Transect Barrier Island Locations

Location	Dominant Taxa	Average Taxa Richness[a]	Average Density (number/square meter) [a]
Petit Bois Island Gulf side (n = 2)	Oligochaetes, Enchytraidae and Tubificidae; Malacostracea, *Lepidactylus sp.*; bivalves, *G. gemma* and *D. variabilis*	1.5–5	800–4,000
Petit Bois Island Miss. Sound side (n = 2)	Malacostracea, Haustoriidae and Mysidae; Polychaete, *Paraonis sp.;* Nemertea; bivalves, *G. gemma* and *D. variabilis*	7.5–14.5	12,000–48,000
Horn Island Gulf side (n = 2)	Malacostracea, *Metamysidopis sp.*, *Ancinus sp.*, *Lepidactylus sp.*; Nemertea; bivalves, *G. gemma* and *D. variabilis*	1.5–4	500–4,000
Horn Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae and Tubificidae; Polychaete, *Paraonis sp.*; Malacostracea, *Lepidactylus sp.*; Nemertea	7–2.5	8,400–24,000
Ship Island Gulf side (n = 2)	Malacostracea, *Lepidactylus sp.* and *Exosphaeroma sp.*; bivalves, *G. gemma* and *D. variabilis*	1.5–3.5	800–2,900
Ship Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae; Polychaete, *Paraonis sp, Leitoscoloplus sp. and* Terebellidae.; Malacostracea, *Spilocuma sp and Houstorius sp.*; bivalves, *G. gemma* and *D. variabilis*	5–9	12,000–45,000
West Horn Island Gulf side (n = 2)	Polychaete, *Paraonis sp, Scolelepis sp.;* Malacostracea, *Acanthohaustorius sp., Spilocuma sp., Pinnixa sp. and Lepidactylus sp.*; bivalves, *G. gemma* and *D. variabilis*	1.5–6	600–3,500
West Horn Island Miss. Sound side (n = 2)	Oligochaetes, Enchytraidae, and Tubificidae; Polychaetes, *Paraonis sp. and Capitella sp.; Malacostracea,* Malacostracea, *Lepidactylus sp.*, *Haustorius sp.,* and *Exosphoeroma sp.* Nemertea	8–15	5,200–25,000
Cat Island (n = 3)[b]	Polychaete, *Paraonis sp*, *Leitoscoloplus s.* and *Nereididae sp.;* Malacostracea, *Lepidactylus sp.*, *Haustorius sp.*, *Spilocuma sp.* and *Exosphoeroma sp.;* bivalves, *D. variabilis* and *Petricola sp.*	2–5	3,500–12,000

[a] Range among depths (3) and events (3)
[b] Cat Island stations were not separated into Sound /Gulf groupings

One distinguishing factor of the beach transect samples was the significantly higher taxa richness and densities observed at stations on the Mississippi Sound side of the barrier islands, relative to those at the Gulf side. Stations located on the Sound side of the islands typically had 2–4 times more taxa, and often an order of magnitude higher densities, than stations located on the Gulf side.

Beach transect assemblages were similar to those found by Rakocinski et al. (1991) at barrier islands with exposed Gulf beaches and protected Sound beaches. In this study, Lepidactylus and Paraonis were found to dominate protected beach habitat, while an isopod, mysid, haustorid amphipods, a cumacean, and a bivalve dominated exposed beaches. In the MSAAS (USACE, 1982), the Shallow Sound sand habitats exhibited macroinvertebrate assemblages similar to those of the beach transect stations and also had lower taxa richness, higher densities, and lower diversity than offshore and tidal pass locations.

4.5.3.2 Mollusks

Important bivalves in the northern Gulf of Mexico include bay scallop (*Argopecten irradians*), Eastern oyster *(Crassostrea virginica)*, and hard clam (*Mercenaria* sp.). These species typically inhabit nearshore coastal areas where they feed on phytoplankton and detritus (Pattillo et al., 1997). Bay scallop, Eastern oyster, and northern and Texas quahog clams (*Mercenaria* and *M. mercenaria texana*) are among the bivalves that have also been identified in estuaries around Mississippi's barrier islands (Cake, 1983).

All lifestages of the bay scallop are estuarine and marine in nearshore, subtidal waters. They have been collected in waters ranging in depth from 0-33 feet down to a maximum of 59 feet, but are most abundant in waters 1–2 feet deep at low tide (Pattillo et al., 1997).

The Eastern oyster is one of the more valuable shellfish resources of the Mississippi Gulf coast. The oysters inhabit shallow estuarine waters during all lifestages. MDMR manages 17 natural oyster reefs (MDMR, 2010a). The areal extent of oyster reefs in Mississippi is estimated at 10,000–12,000 acres (4,000-4,900 hectares), of which 7,400 acres (3,000 hectares) are located in western Mississippi Sound (MDWFP, 2005). Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs. No actively managed oyster reefs are present in close proximity to the barrier islands (MDMR, 2010a). The hard clam is an estuarine and marine species most often found in coastal bays from intertidal zones to water depths of 50 feet. These clams may be found in open ocean, but prefer shallow waters (<33 feet). Juvenile and adult clams occur primarily in soft bottom habitats of sand and mud. Spawning coincides with high concentrations of plankton during spring, fall, and winter (Pattillo et al., 1997).

The Atlantic oyster drill (*Thais haemastoma*) is a significant predator of the economically important Eastern oyster. The species prefers the small juvenile stage of the oyster over larger adults. Predation rates for drills 50 mm in size have been documented at 85 2-week-old spat per day. The drill tolerates a range of salinities, but prefers the more saline parts of estuaries. Its destructiveness to oyster beds increases as salinity increases. Reproduction occurs in waters with salinity above 20 ppt (Butler, 1985). Localized population increases in this species have occurred in Gulf coast areas that have experienced increases in salinity (Alabama Current Connection, 2011).Other abundant mollusks found in Mississippi Sound include various gastropods (snails, limpets, nudibranchs, and sea slugs) and cephalopods (octopods and squids).

During a 3-year (1987–1989) evaluation of the continental shelf, over 23,000 epifaunal invertebrates, including 310 recognizable species, were observed. Of these, mollusks comprised 7.7 percent of the sample. Sample results suggested that mollusks were more widespread and abundant during the summer months than during the winter. The abundance patterns of the macroinfauna were not shown to be dependent on sediment type (MMS, 1991).

4.5.3.3 Crustaceans

Crustaceans of abundance in Mississippi Sound include a variety of amphipods, isopods, shrimps, and crabs. Three commercially important species of shrimp and one commercially important species of crab are found in Mississippi coastal waters: the brown shrimp *(Penaeus aztecus)*, the pink shrimp (*Penaeus duorarum),* the white shrimp *(Penaeus setiferus),* and the blue crab (*Callinectes sapidus).*

The life histories of the shrimp species are generally similar, although the time of spawning varies among the species. Mating takes place in shallow offshore waters, while actual spawning takes place in deeper offshore waters. The eggs are released and fertilized externally in the water. Within 24 hours, fertilized eggs hatch into a microscopic larva. The larvae are capable of only limited horizontal, directional movement in response to light conditions and are unable to swim independently of the water currents. Shrimp migrate via currents from offshore waters to coastal bays during the last planktonic stage and enter estuarine nursery grounds as post-larvae. Development to the post-larval stage takes several weeks. Post-larvae have well developed swimming capabilities. Once they move into brackish waters, the post-larvae abandon their planktonic way of life and become part of the benthic community. Young shrimp remain in the estuary until they approach maturity. Adult shrimp migrate offshore to spawn, and the cycle is repeated.

As noted above, there are seasonal variations in the spawning times of pink, brown, and white shrimp. Brown post-larvae enter Mississippi Sound in large numbers during the spring, with a smaller wave of migration in the fall. White and pink shrimp post-larvae arrive during the summer and fall, with white post-larvae being more abundant. Of the three species, white shrimp spawn closest to the shore and brown shrimp spawn the farthest from shore (Perry, 2010*).* Brown shrimp inhabit offshore waters ranging from 45–360 feet in depth and adults are most abundant from June to October (Pattillo et al., 1997; MDMR, 2010b). Mature pink shrimp inhabit deep offshore waters, and the highest concentrations occur in depths of 33–145 feet (Pattillo et al., 1997). Pink shrimp are most abundant in winter and early spring. They are usually found in higher-salinity waters and are generally caught at night (MDMR, 2010b). White shrimp adults are typically found in nearshore waters rarely exceeding 90 feet in depth and generally become most abundant at about 45 feet in depth (Pattillo et al., 1997). White shrimp are caught mostly during daylight hours in the fall months and can be found in shallower waters with mud bottoms (MDMR, 2010b).

Brown shrimp comprise approximately 85 percent of Mississippi's harvest. Brown shrimp are most abundant from June to October and can be found in inshore and offshore waters. White shrimp, found in shallower waters over mud bottoms, are caught mostly during daylight hours during the fall months. Pink shrimp are usually found in higher-salinity waters and are generally caught at night. These shrimp are most abundant in winter and early spring. Water temperatures, salinity, available food, and habitat area affect the size of the shrimp harvest. The most productive seasons are those when water conditions are warm and brackish, i.e., in the spring (MDMR, 2010b).

The blue crab is another commercially important crustacean. The blue crab spends most of its life in bays, brackish estuaries, and nearshore areas in the Gulf of Mexico. Spawning occurs near the mouths of estuaries or in open water (Pattillo et al., 1997). Crabs have a long spawning period in Mississippi and egg-bearing crabs may be found in all but the coldest months. Females with eggs are found around barrier islands (e.g., Horn Island and Petit Bois) in large numbers during the summer (MDMR, 2010c). Eggs hatch near those areas and planktonic zoeal larvae are carried offshore for up to 1 month to spend their larval stage in the offshore plankton (Pattillo et al., 1997; MDMR, 2010c). Once metamorphosis to the megalopa stage is complete, they re-enter estuarine waters to develop before molting into the crab stage. Spawning activity is greatest in late spring and late summer. Most adult crabs move to deeper waters during winter (Pattillo et al., 1997).

During a 3-year (1987—1989) evaluation of the continental shelf, decapods comprised approximately 77.8 percent of the epifaunal invertebrates observed. The dominance of decapods was due to the large numbers of shrimp sampled. Sample results suggested that decapods prefer coastal marshes during the summer and migrate to deeper waters during the winter (MMS, 1991).

4.5.4 Fish

Christmas and Waller (1973) reported 138 species of finfish taken in trawl surveys from Mississippi Sound. The most abundant species was the bay anchovy, comprising over 70 percent of the reported catch. Six species have been identified as being dominant in the Pascagoula Harbor area year-round: bay anchovy, Gulf menhaden, Atlantic croaker, spot, harvestfish (*Peprilus alepidotus*), and sand seatrout or white trout (*Cynoscion arenarius*) (USEPA, 1991; Hoese and Moore, 1998). In general, movement of fish into the Pascagoula estuaries occurs mainly from January to June, while migration back into the Gulf typically occurs from August to December (USEPA, 1991). As part of an NCA program, the MDEQ conducted fishery trawl surveys in Mississippi Sound from 2000–2004. These surveys identified 56 species of finfish in Mississippi Sound.

The fish community in the vicinity of the Mississippi barrier islands represents a wide array of species from both nearshore and offshore taxa. Christmas and Waller (1973) report that 98 percent of the fishes collected in Mississippi Sound were also present in offshore trawl samples. The majority of the fish species present are estuarine-dependent for part of their life cycle. Although three anadromous fish species (Alabama shad [*Alosa alabamae*], striped bass [*Morone saxatilis*], and Gulf sturgeon) occur, typically, fish species found in Mississippi Sound spawn in the Gulf of Mexico and the larvae (ichthyoplankton) are carried inshore to estuaries to mature (USEPA, 1991). These small, immature forms are susceptible to flow regime changes around the barrier islands (Horn and Petit Bois Islands) where the surrounding grassbeds provide nursery grounds. The greatest abundance of larvae occurs in the spring and summer. There were 69 species of ichthyoplankton recorded from the Horn Island surf zone, which were dominated in numerous studies by six species: striped anchovy (*Anchoa hepsetus*), dusky anchovy (*Anchoa lyolepis*), bay anchovy (*Anchoa mitchilli*), scaled sardine (*Harengula jaguana*), Gulf kingfish (*Menticirrhus littoralis*), and Florida pompano (*Trachinotus carolinus*) (Ross, 1983). Other dominant larval forms included Gulf menhaden (*Brevoortia patronus*), spot (*Leiostomus xanthurus*), silversides (*Menidia* sp.), and southern kingfish (*Menticirrhus americanus*) (Ross, 1983), and Florida pompano. These species are most abundant in late spring and summer and again in late winter. Fish abundance at given locations within the surf zone are affected by tide level, time of day, and water temperature (Modde and Ross, 1981).

Because of the importance of Mississippi Sound to the fish community, MDMR has created 15 offshore reef sites to help maintain and enhance fisheries (Figure 4-6). These reefs cover a total of approximately 16,000 acres and range in size from 3–10,000 acres.

The sites located north of the barrier islands consist of concrete rubble. Those located south of the barrier islands consist of concrete culverts, steel hull vessels, and artificial reef pyramids. All of the reefs are located outside the boundaries of GUIS.

The artificial reef nearest to a proposed sediment borrow or placement area is Cat Island reef. It is located approximately 0.5 mile east of Cat Island and 0.5 mile south of the proposed Cat Island borrow area. Reefs FH-4, FH-5, and FH-14 are located approximately 2 miles south or east of the proposed Ship Island borrow areas. FH-9/11 is located approximately 2 miles north of Ship Island. There are no other reefs within approximately 2 miles of the project area (MDMR, 2010a).

The major fishery of the Mississippi Sound area is Gulf menhaden. Gulf menhaden is a commercially important species typically harvested from April to October as they move inshore from offshore wintering grounds on the continental shelf (Pattillo et al., 1997).

Larvae can begin migration into estuaries in October and continue through late May, while adults and maturing juveniles migrate from estuaries to open Gulf waters to overwinter and reproduce, with peak movement occurring from October to January (Pattillo et al., 1997). Other commercially important fisheries of the Mississippi coastal area include the striped mullet (*Mugil cephalus*) and Atlantic croaker (*Micropogonias undulates*) (USEPA, 1991). Striped mullet juveniles enter estuarine areas from November through February. Adults move offshore in Gulf waters to overwinter and spawn from October to March. Peak spawning occurs in November and December (Pattillo et al., 1997). The Atlantic croaker is the most important commercial species of bottomfish, and major harvesting areas are located between Mobile Bay, Alabama and Calcasieu Lake, Louisiana (Pattillo et al., 1997). Larvae are carried by longshore currents into nearshore areas from October to May, peaking between November and February (Pattillo et al., 1997). Offshore movement by mature juveniles and adults begins in late March and continues until November. Spawning occurs from September to May, peaking in October (Pattillo et al., 1997).

The fish community on the continental shelf south of the barrier islands is composed of a variety of offshore taxa. Commercial fishing on the Mississippi-Alabama continental shelf includes purse seining for menhaden, trawling for demersal fish species, and using hook and line (trolling, bottom lining, and longlining) for reef-related as well as coastal and offshore pelagic species (e.g., bluefin tuna, swordfish) (MMS, 1991). A study of the fish community in the OCS found that fish densities were higher during summer months compared to winter months. During summer months, densities were highest at relatively shallow stations. During winter months, a reduction of fish species diversity was observed at the shallowest stations and an increase in diversity at deeper stations. This suggests that fish migrate offshore to greater depths during the colder months. Size class analysis indicates that most of the demersal fish species of the Mississippi-Alabama continental shelf have life histories between 1 and 2 years long, with a range of spawning season lengths (MMS, 1991).

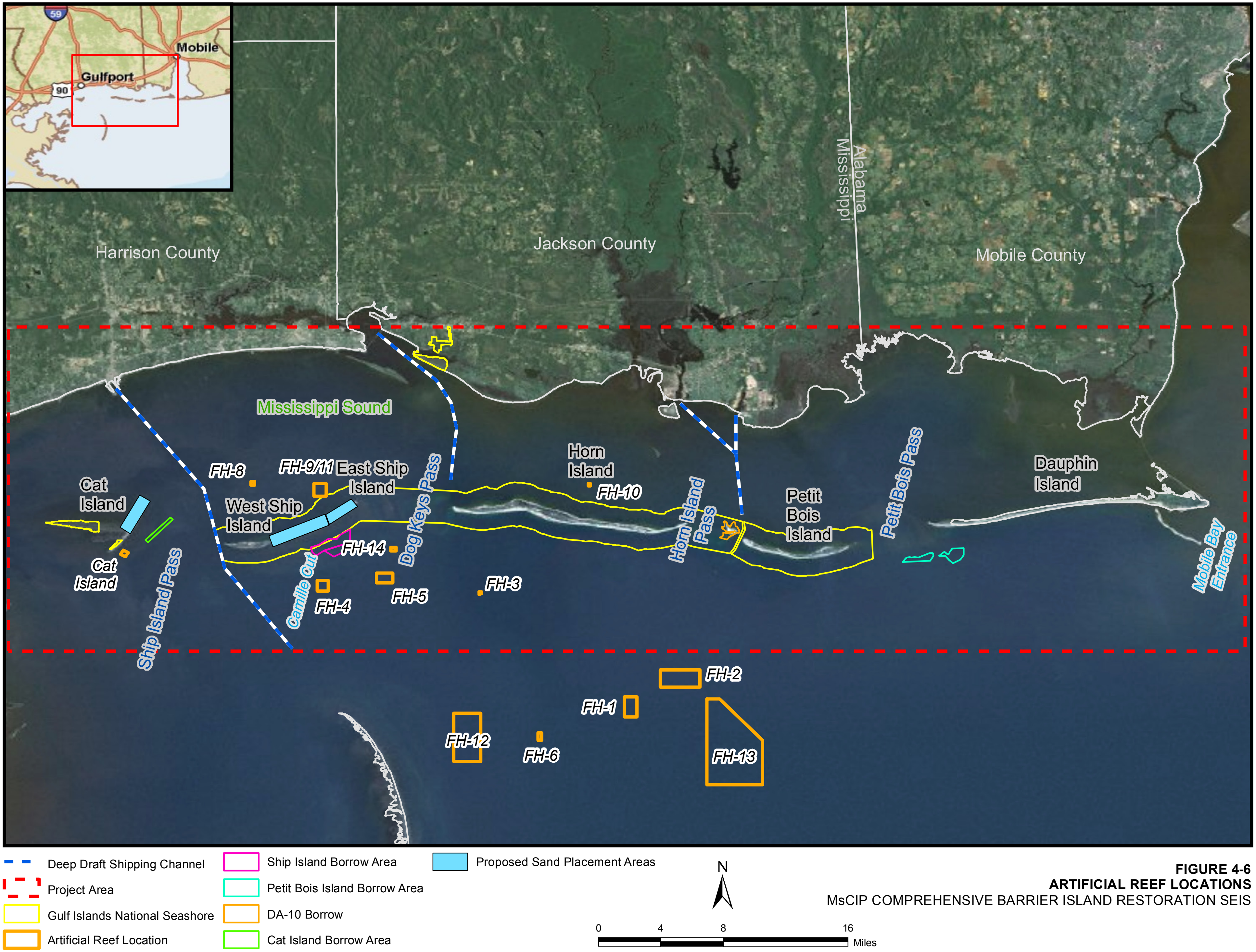


FIGURE 4-6
ARTIFICIAL REEF LOCATIONS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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4.5.4.1 Fish Tissue Contaminants

Fish consumption advisories for mercury have been issued for several species of fish in the Gulf of Mexico. Three species (king mackerel larger than 39 inches, bluefish, and blacktip shark) have a Gulf-wide mean mercury concentration between 0.86 and 1.0 ppm. Fish consumption advisories are issued at different levels in each state, but generally a mercury level of 1.0 ppm triggers an advisory for the general public to limit consumption. Special populations, such as children and pregnant women, may be advised to limit consumption when mercury levels reach 0.5 ppm. Other species with mercury levels greater than 0.5 ppm include Spanish mackerel, jack crevalle, bonnethead shark, and sand seatrout (Ache et al., 2000).

The MDEQ published a consumption advisory concerning mercury for the Gulf of Mexico in 1998. Specifically, the advisory was for king mackerel and suggested that people limit the amount of 33- to 39-inch king mackerel (no more than 1 meal every 2 months) and avoid eating all king mackerel longer than 39 inches (MDEQ, 2010b).

4.5.5 Marine Mammal Communities

All marine mammals are protected by the Marine Mammal Protection Act (MMPA) of 1972, as amended, but the West Indian manatee and five whale species, which include the blue, finback, humpback, sei, and sperm whales, are also listed as endangered and, therefore, are also protected under the Endangered Species Act (ESA). The MMPA prohibits, with certain exceptions, the *take* of marine mammals in U.S. waters and by U.S. citizens on the high seas, and the importation of marine mammals and marine mammal products into the U.S.

Twenty-nine marine mammal species (Table 4-6), including the West Indian manatee, have been or are known to occur in the Gulf of Mexico. Most of these marine mammals are unlikely to be in the project area due to its shallow waters. Based on NOAA Fisheries aerial surveys, the most often sighted groups along the upper continental slope of the north-central Gulf of Mexico were Risso's dolphin, Atlantic bottlenose dolphin, Atlantic spotted dolphin, pantropical spotted dolphin, striped, spinner, and clymene dolphin, sperm whale (*Physeter macrocephalus*), dwarf and pygmy sperm whales, and short-finned pilot whale (Evans, 1999; Waring et al., 2013). However, sperm whales tend to inhabit areas with a water depth of 1,968 feet (600 meters) or more, and are uncommon in waters less than 984 feet (300 meters) deep. Of the species sited along the upper continental shelf, three marine mammal species are commonly found along nearshore areas of the continental shelf, near the Mississippi Sound barrier islands, and within Mississippi Sound. They include Atlantic bottlenose dolphin, Atlantic spotted dolphin (*Stenella frontalis*), and spinner dolphin (*Stenella longirostris*) (MMS, 2000; Waring et al., 2013). In recent years, the West Indian manatee has become a more common transient, frequently migrating from Florida along the coast as far as Louisiana in warmer weather. However, this species typically remains close to the coast and would not be expected near the barrier islands.

Other marine mammal species, such as whales, are inhabitants of the deeper waters off the continental shelf. They would be unlikely to be encountered in Mississippi Sound but these animals could appear as transients through the area. No sightings of these species have been recorded near the project area (Waring et al., 2013).

TABLE 4-6
Marine Mammals Occurring in the Gulf of Mexico

Scientific Name	Common Name
Balaenoptera acutorostrata	Minke whale
Balaenoprera borealis	Sei whale[a]
Balaenoptera edeni	Bryde's whale
Balaenoptera musculus	Blue whale[a]
Balaenoptera physalus	Finback whale[a]
Eubalaena glacialis	Northern right whale
Feresa attenuate	Pygmy killer whale
Globicephala macrorhynchus	Short-finned pilot whale
Grampus griseus	Risso's dolphin
Kogia breviceps	Pygmy sperm whale
Kogia simus	Dwarf sperm whale
Lagenodelphis hosei	Fraser's dolphin
Megaptera novaeangliae	Humpback whale[a]
Mesoplodon bidens	Sowerby's beaked whale
Mesoplodon densirostris	Blainville's beaked whale
Mesoplodon europaeus	Gervais' beaked whale
Orcinus orca	Killer whale
Peponocephala electra	Melonheaded whale
Physeter macrocephalus	Sperm whale[a]
Pseudorca crassidens	False killer whale
Stenella attenuate	Pantropical spotted dolphin
Stenella clymene	Clymene dolphin
Stenella coeruleoalba	Striped dolphin
Stenella frontalis	Atlantic spotted dolphin
Stenella longirostris	Spinner dolphin
Steno bredanensis	Rough toothed dolphin
Trichechus manatus	West Indian manatee[a]
Tursiops truncatus	Atlantic bottlenose dolphin
Ziphius cavirostris	Cuvier's beaked whale

Sources: MMS, 2000; NOAA Fisheries, 2010a.
[a] Protected under the ESA of 1973 as endangered.

The western north Atlantic bottlenose dolphin populations found along the mid-Atlantic coast have been designated as depleted under the MMPA and, therefore, are more stringently managed to replenish them (NOAA Fisheries, 2010a). The Gulf of Mexico population, however, is not considered to be at risk and is managed less stringently. Mississippi Sound is home to the largest stable population of Atlantic bottlenose dolphins in the world, generally because of the warm and protected waters (Institute for Marine Mammal Studies [IMMS], 2007). Atlantic bottlenose dolphins inhabiting different areas of the bays and sounds form distinct communities. Seasonal migration of bottlenose dolphins is indicated by changes in abundance within a population in Mississippi Sound. It is likely that interbreeding can occur between Mississippi Sound dolphins and those that typically remain in the northern Gulf of Mexico (IMMS, 2007).

4.5.6 Marine and Coastal Birds

The Gulf coast, including the Alabama coast, Mississippi coast, Mississippi Sound, and the barrier islands, provides feeding, nesting, resting, and wintering habitat for numerous resident and migratory bird species (MDMR, 2010d). Over 300 species of birds have been reported as migratory or permanent residents within the area, including several species that breed there. Shorebirds found in the area include osprey, great blue heron, great egret, piping plover, sandpiper, gulls, brown and white pelicans, American oystercatcher, and terns (USACE, 2009a).

The project area serves as part of an important migration corridor (i.e., the Mississippi Flyway) for birds migrating to and from tropical wintering areas in the Caribbean, Mexico, and Central and South America. The majority of the birds migrating through the Mississippi Flyway in spring and fall cross the Gulf of Mexico. The coastal woodlands and narrow barrier islands that lie scattered along the northern coast of the Gulf of Mexico provide important stopover habitat for these neotropical landbird migrants. They represent the last possible stopover before fall migrants make a non-stop flight (18–24 hours) of greater than 1,000 kilometers (km), and the first possible landfall for birds returning north in spring (USACE, 2009a).

4.5.6.1 Barrier Islands

The Mississippi Sound barrier islands represent the primary marine and coastal bird habitat in the project area. These islands feature a variety of habitat types, including subtidal estuarine habitat, open beaches, pond and lagoon complex, freshwater and saltwater marshes, wooded inland, and seagrass beds and mollusk reefs offshore (MDMR, 2010d).

More than 280 species of birds have been identified within the island boundaries (NPS, 2010a). Between 1992 and 1994, bird research was conducted on Horn Island and East and West Ship Islands and found that approximately 74 species of land-based migratory birds use the area as a stopover (University of Southern Mississippi, 2010). Twenty-three common (5-25 individuals per day) permanent resident birds have been identified on and around the Mississippi barrier islands (USGS, 2007). The greatest number of migrating birds is typically observed in April and May and early September through mid-October (Moore et al., 1990).

Bird surveys conducted in support of the MsCIP barrier island restoration project included weekly observations at five locations (eastern and western East Ship Island, eastern and western West Ship Island, and DA-10/Sand Island) from December 2012 through December 2013. Bird survey data are provided in Appendix J; figures in Appendix J show the number of species and total number of birds collected monthly at each of these locations. Species observed on West Ship Island included American oystercatcher, piping plover, red knot, reddish egret (*Egretta rufescens*), short-billed dowitcher (*Limnodromus griseus*), snowy plover (*Charadrius nivosus*), western sandpiper (*Calidris mauri*), marbled godwit (*Limosa fedoa*), and Wilson's plover (*Charadrius wilsonia*). On East Ship Island, these same species were observed, in addition to the stilt sandpiper (*Calidris himantopus*). More birds were observed on Ship Islands during the months April through August than during the months December through March, with the exception of the west end of East Ship Island, which had a relatively large number of birds during the months October through December as well. Among Ship Islands, the total number of birds observed was largest (30,730 birds) on the west end of East Ship Island and smallest (9,287) on the east end of East Ship Island.

The barrier islands serve as important breeding habitat and contain rookeries for several species (MDMR, 2010d). Some of the solitary nesting bird species known to regularly breed on the barrier islands include the American egret (*Ardea alba*), snowy egret (*Egretta thula*), black nighthawk (*Chordeiles minor)*, yellow nighthawk, great blue heron (*Ardea herodias*), willet (*Tringa semipalmata*), American oystercatcher, snowy plover, and Wilson's plover (GUIS, 2012). In addition, the white ibis (*Eudocimus albus*) is known to breed on Cat Island and the Louisiana heron (*Egretta tricolor*) on Petit Bois Island (GUIS, 2012). Nighthawks nest on unsheltered ground, such as sand dunes and gravel beaches. Most plover nests are found on the bare sand, high on the beach with scattered vegetation. It should be noted, however, that piping plovers do not nest in the project area. Adult plovers and young move down to the tidal flats and shoreline to feed and retreat to the vegetation for cover. Willets feed openly along the shoreline. The American oystercatcher nests on the open beach, usually next to a clump of vegetation or other cover. The adults are quite vocal and are easily seen feeding at the water's edge (NPS, 2011). The great blue heron occurs in areas that include brackish marshes and ocean beaches. It commonly nests high in trees in swamps and forested areas. The Louisiana heron can be found in several types of habitats ranging from marshes to salt- and freshwater islands. It mainly nests near saltwater marshes or bare coastal islands (NatureServe, 2010).

Colonial nesting species known to regularly breed on the barrier islands include the gull-billed tern (*Gelochelidon nilotica*), least tern (*Sterna antillarum*), sandwich tern (*Thalasseus sandvicensis*), royal tern (*Thalasseus maximus*), and black skimmer (GUIS, 2012). These species nest in mixed colonies on the high sparsely or unvegetated beach (Hopkins, 2011). Once the chicks have matured and have developed plumage, the adults move them down to the water's edge until they are able to forage and fledge. The least tern requires open sandy coastal beaches and river sandbars for nesting. It nests in scrapes in sand above ordinary high tides and breeds during the summer months. The sandwich tern prefers seacoasts, bays, estuaries, mudflats, and lagoons. It nests with the royal tern on unvegetated bare sand or sand-shell substrates. The royal tern nests typically on open sandy beaches, sandbars, and sand/shell substrates. The black skimmer nests primarily near coasts on sandy beaches, coastal and estuary islands, on wrack and drift of salt marshes, and on dredged material sites. These birds usually nest in association with or near terns (NatureServe, 2010).

Two species of raptor, the osprey (*Pandion haliaetus*) and bald eagle (*Haliaeetus leucocephalus*), are known to breed on the barrier islands. The bald eagle breeding habitat is generally close to coastal areas and large bodies of freshwater; the bald eagle usually nests in tall trees or on cliffs near water. Ospreys nest along streams and in coastal areas in living and dead trees, but also on several different types of man-made structures (NatureServe, 2010). Breeding seasons for most of these species typically occur between April and June, with young birds remaining through August or September. Eagles, however, breed over winter, typically from September 1 to April 30.

The barrier islands also serve as wintering habitat for the federally protected piping plover. Cat, Ship, Horn, Petit Bois, and Round Islands have been designated critical habitat for the wintering piping plover (USFWS, 50 C.F.R. § 17). Plovers begin arriving on wintering grounds in early July and continue arriving into September. Although some individuals can be found on the wintering grounds throughout the year, most plovers depart in spring and sightings are rare in June and early July (USFWS, 2010a). The piping plover is further discussed in Section 4.5.8.

The red knot, a bird species proposed for listing under the ESA, has also been observed on the wintering grounds of East Ship Island, Cat Island, and Petit Bois Island (Necaise, personal comm., 2012). The red knot is further discussed in Section 4.5.8. The reddish egret has been observed on East Ship Island, West Ship Island, Horn Island, and Petit Bois Island during fall migration (Zdravkovic, 2010).

4.5.6.2 DA-10/Sand Island

DA-10 contains a 165-acre island created by placement of dredged material from dredging activities associated with the Pascagoula Federal navigation project. The island is vegetated in areas, but serves as habitat for shorebirds. Historically, the island has been a consistent colonial shorebird nesting site, with the largest number and diversity of species in the Mississippi District of the GUIS. Pre-Katrina, nesting colonies were documented to consist of several thousand birds. The island supports a variety of bird habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune (NPS, 2011).

During bird surveys conducted in support of the MsCIP barrier island restoration project, species observed on Sand Island included the American oystercatcher, piping plover, red knot, snowy plover, and western sandpiper. More birds were observed in May (1,150 birds) and June (2,134 birds) than in other months. No birds were observed in July through December and less than 300 birds were observed monthly, during the months January through April.

Colonial nesting species observed on the island include least terns, black skimmers, royal terns, sandwich terns, black terns (*Chlidonias niger*), common terns (*Sterna hirundo*), and gull-billed terns (Hopkins, 2011; GUIS, 2012). Since 2005, colonies have ranged from 350 to over 500 birds. In 2010 the nesting colony consisted of 409 pairs of least terns, 103 black skimmers, and 11 gull-billed terns (NPS, 2011). Solitary nesting shorebirds observed include the American egret, snowy egret, black nighthawk, yellow nighthawk, willet, American oystercatcher, snowy plover, Wilson's plover, and great blue heron (GUIS, 2012). In 2010, two pairs of snowy plovers, one pair of willets, one pair of American oystercatchers, and one pair of Wilson's plovers were observed nesting (NPS, 2011). The reddish egret has also been observed on Sand Island during the fall migration (Zdravkovic, 2010).

4.5.7 Hard Bottom Habitats

Natural hard bottom habitats serve as important spawning areas for fish species and support unique communities of marine organisms. "Hard" or "live" bottom habitat refers to "those areas which contain biological assemblages consisting of such sessile invertebrates as sea fans, sea whips, hydroids, anemones, ascidians, sponges, bryozoans, or corals living upon or attached to naturally occurring hard or rocky formations with rough, broken, or smooth topography; or areas whose lithotope favors the accumulation of turtles, fishes, and other fauna" (Thompson et al., 1999).

No natural hard bottom habitats are located within Mississippi Sound. A small area of rock outcrop and consolidated features is found approximately 3 miles south of Mississippi's barrier islands. Most hard bottom habitats lie east of the Mississippi coast, although some calcareous outcrops occur south of Biloxi in 60 feet of water and along most of the continental shelf within the 150- to 300-foot depth. Small, isolated patches of lag deposits composed of shell and rock gravel are found off the south sides of the barrier islands (MDWFP, 2005). Some artificial reefs consisting of concrete rubble, concrete culverts, steel hull vessels, and artificial reef pyramids have been placed near the project area, as discussed in Section 4.5.4 above.

4.5.8 Rare, Threatened, and Endangered Species

Table 4-7 presents the species listed by USFWS as either threatened or endangered, or as a candidate for federal protection that may occur in the project area. This includes Hancock, Harrison and Jackson Counties, Mississippi, as well as waters offshore of Mississippi and Alabama. Table 4-7 also includes 12 species that NOAA Fisheries, Protected Resource Division, St. Petersburg Field Office lists that may occur within the area under their purview as threatened and/or endangered. Five of these species are also listed by USFWS (Table 4-7).

TABLE 4-7
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Inflated Heelsplitter	*Potamilis inflatus*	LT	Hancock County	Historically in the Pearl River drainage. Prefers soft, stable substrata in slow to moderate currents on the protected side of bars and may occur in depths exceeding 20 feet (USFWS, 1993a).
Red Knot [b]	*Calidris canutus ssp. rufa*	C	County-level range has not been defined in Mississippi or Alabama	Sandy beaches, tidal mudflats, salt marshes, and peat banks (USFWS, 2011).
Pearl Darter	*Percina aurora*	C	Jackson County (Pascagoula River system)	Deeper runs and pools with larger substrate particle size. In rivers and large creeks with moderate current (USFWS, 2010b).
Mississippi Gopher Frog	*Rana sevosa*	LE	Harrison County	Upland sandy habitats, historically forest dominated by longleaf pine (*Pinus palustris*), and isolated temporary wetland breeding sites embedded within the forested landscape (USFWS, 2010c).
Alabama Red-bellied Turtle	*Pseudemys alabamensis*	LE	Harrison and Jackson Counties	Sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (USACE, 2009a; USFWS, 1990a).
Black Pine Snake	*Pituophis melanoleucus lodingi*	C	Hancock, Harrison, and Jackson Counties	Well-drained, upland longleaf pine forests with a fire-suppressed mid-story and dense herbaceous ground cover (USACE, 2009a).
Eastern Indigo Snake	*Drymarchon corais couperi*	LT	Hancock, Harrison, and Jackson Counties	Dry, mature pinelands dominated by longleaf pine, with a fire-maintained subclimax understory community (USFWS, 1982, 2010f).

TABLE 4-7
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Gopher Tortoise	*Gopherus polyphemus*	LT	Hancock, Harrison, and Jackson Counties	Longleaf pine hills with well-drained, sandy soils, an abundance of herbaceous ground cover, and a generally open canopy with sparse shrub cover (USACE, 2009a; USFWS, 1990b).
Ringed Map Turtle	*Graptemys oculifera*	LT	Hancock	
Yellow-blotched Map Turtle	*Graptemys flavimaculata*	LT	Jackson County	Main channels of rivers and large creeks, oxbow lakes (USFWS, 1993b).
Mississippi Sandhill Crane	*Grus canadensis pulla*	LE	Jackson County	Nests in open area of grasses/sedges with perennial shallow water, often near grasslands, pasture, or open pine forests. Forages in savannas, swamps, and open forest lands, corn and chufa fields, pastures, and pecan orchards. Roosts in fresh and brackish marshes, freshwater ponds, open forests, pastures, and moist clearings (USFWS, 1991).
Piping Plover [b]	*Charadrius melodus*	LT and Critical Habitat	Hancock, Harrison, and Jackson Counties	Barrier islands, along sandy peninsulas, and near coastal inlets. Also on sand, mud, and algal flats, washover passes, salt marshes, and coastal lagoons (USFWS, 1996).
Red-Cockaded Woodpecker	*Picoides borealis*	LE	Harrison and Jackson Counties	Open pine woodlands with large old pine trees (USFWS, 2003a).
Louisiana Black Bear	*Ursus americanus luteolus*	LT	Hancock, Harrison, and Jackson Counties	Bottomland hardwood forests (USACE, 2009a).
West Indian Manatee	*Trichechus manatus*	LE	Mississippi Sound	In marine, estuarine, and freshwater environments (USACE, 2009a).
Louisiana Quillwort	*Isoetes Louisianensis*	LE	Hancock, Harrison, and Jackson Counties	Sandy soils and gravel bars in or near shallow blackwater streams and overflow channels in riparian woodland/ bayhead forests of pine flatwoods and upland longleaf pine (USACE, 2009a; USFWS, 2010d).
Green Sea Turtle [b]	*Chelonia mydas*	LT (USFWS and NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (USACE, 2009a).
Kemp's Ridley Sea Turtle [b]	*Lepidochelys kempii*	LE (USFWS and NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Nearshore and inshore waters of the northern Gulf of Mexico, especially Louisiana waters (NOAA Fisheries et al., 2010).

TABLE 4-7
Federally Listed Threatened and Endangered Species in Hancock, Harrison and Jackson Counties, Mississippi, and Offshore Waters of Mississippi and Alabama

Common Name	Scientific Name	Status[a]	Area of Potential Occurrence	Habitat
Loggerhead Sea Turtle [b]	*Caretta*	LE (USFWS) LT (NOAA)	Mississippi Sound and oceanward waters near the barrier islands	Ocean beaches and estuarine shorelines with suitable sand and relatively narrow, steeply sloped, coarse-grained beaches (USACE, 2009a).
Leatherback Sea Turtle[b]	*Dermochelys coriacea*	LE	Mississippi Sound and oceanward waters near the barrier islands	High energy beaches with deep, unobstructed access along continental shorelines. Oceans worldwide.
Hawksbill Sea Turtle [b]	*Eretmochelys imbricate*	LE	Mississippi Sound	Coral reefs, shoals, lagoons, lagoon channels, and bays with marine vegetation; also can tolerate muddy bottoms with sparse vegetation.
Gulf Sturgeon [b]	*Acipenser oxyrhynchus desotoi*	LT (USFWS and NOAA)	Hancock, Harrison, and Jackson Counties, and offshore waters	Rivers, estuaries, and Gulf of Mexico waters (USFWS and NOAA Fisheries, 2009).
Smalltooth Sawfish	*Pristis pectinata*	LE (USFWS and NOAA)	Mississippi Sound (no County-level range identified)	Very shallow coastal waters, particularly shallow mud banks and mangrove habitats and offshore at depths up to at least 400 feet (NOAA Fisheries, 2009a).
Blue Whale	*Balaenoptera musculus*	LE	Offshore waters	Offshore waters.
Finback Whale	*Balaenoptera physalus*	LE	Offshore waters	Offshore waters.
Humpback Whale	*Megaptera novaeangliae*	LE	Offshore waters	Offshore waters.
Sei Whale	*Balaenoptera borealis*	LE	Offshore waters	Offshore waters.
Sperm Whale	*Physeter macrocephalus*	LE	Offshore waters	Offshore waters.

[a] LE = Listed Endangered; LT = Listed Threatened, C = Candidate for listing
[b] Species with the potential to occur in the project area.

There are seven federally listed species, two critical habitat designations for piping plovers and Gulf sturgeon, and one candidate species for federal protection that may occur in the vicinity of the proposed project and could be affected by construction activities. A summary of species that are removed from further discussion is included in Section 4.5.8.1. Species that could be affected by construction activities are listed in Sections 4.5.8.2 through 4.5.8.9. In addition, a biological assessment (BA) addressing potential impacts on protected species has been prepared for the proposed project (Appendix N).

4.5.8.1 Species Not Discussed Further

Due to a lack of suitable habitat and their location in coastal upland coastal freshwater, or nearshore coastal estuarine environments, the following 13 species would not occur in or around the barrier islands or sediment borrow areas and are not further discussed:

- Inflated heelsplitter
- Pearl darter
- Mississippi gopher frog
- Black pine snake
- Eastern indigo snake
- Gopher tortoise
- West Indian manatee
- Yellow-blotched map turtle
- Louisiana black bear
- Mississippi sandhill crane
- Red-cockaded woodpecker
- Louisiana quillwort
- Ringed map turtle

The Alabama red-bellied turtle is listed as endangered under the ESA (USFWS, 2010e) and is known to occur in the lower reaches of the Old Fort Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and the Tchoutacabouffa and Biloxi Rivers in Harrison County (USACE, 2009a). The Alabama red-bellied turtle is a freshwater, herbivorous turtle that (USFWS, 1990a) is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers (USACE, 2009a, USFWS, 1990a). Several Alabama red-bellied turtle hatchlings have been found on Horn Island (Necaise, personal comm., 2012). These turtles were perhaps introduced to the island by humans. However, the estuarine habitats on the Mississippi barrier islands and DA-10/Sand Island are not suitable to sustain a viable, healthy population of these species. Therefore, these species are not discussed further.

The smalltooth sawfish is listed as endangered under the ESA (NOAA Fisheries, 2009a and NOAA Fisheries, 2009b) and was once encountered commonly from Texas to North Carolina. The species is now known to occur regularly only in south Florida. The fish prefers very shallow coastal waters of bays, banks, estuaries, and river mouths, particularly shallow mud banks and mangrove habitats, although larger smalltooth sawfish may occur offshore at depths up to at least 400 feet. There is no designated critical habitat for the smalltooth sawfish in the project area (NOAA Fisheries, 2009b). Because of the distance from known populations and the lack of preferred habitat, this species is unlikely to occur in the project area and is not discussed further.

Whale species protected under NOAA Fisheries are unlikely to occur in the project area due to its shallow waters. If offshore locations are included in the TSP, whales would likely avoid the construction area due to noise. The following species are therefore not further discussed:

- Blue whale
- Finback whale
- Humpback whale
- Sei whale
- Sperm whale

4.5.8.2 Gulf Sturgeon and Gulf Sturgeon Critical Habitat

NMFS and USFWS jointly designated GSCH on April 18, 2003 (68 *Federal Register* [Fed. Reg.] 13370, March 19, 2003). GSCH is shown on Figure 4-7. Within the project vicinity, the GSCH is identified as Unit 8 (approximately 881,280 acres), Lake Pontchartrain, (east of causeway), Lake St. Catherine, Little Lake, the Rigolets, Lake Borgne, Pascagoula Bay, and Mississippi Sound systems in Louisiana and Mississippi, and sections of the state waters within the Gulf of Mexico. The primary constituent elements essential for the conservation of the Gulf sturgeon are those habitat components that support foraging, water quality, sediment quality, and safe unobstructed migratory pathways. This unit provides juvenile, subadult and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations (68 Fed. Reg. 13395). One or both of these subpopulations have been documented by tagging data, historic sightings, and incidental captures as using Pascagoula Bay, the Rigolets, the eastern half of Lake Pontchartrain, Little Lake, Lake St. Catherine, Lake Borgne, and Mississippi Sound, within 1 nautical mile of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Appendix N). Substrate in these areas ranged from sand to silt, all of which contain known Gulf sturgeon prey items (Appendix N).

Incidental captures and recent studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in Mississippi Sound, particularly around barrier islands and passes (Appendix N). Gulf sturgeon exiting the Pascagoula River move both east and west, with telemetry locations as far east as Dauphin Island and as far west as Cat Island and the entrance to Lake Pontchartrain (Ross et al., 2009). Tagged Gulf sturgeon from the Pearl River subpopulation have been located between Cat Island, Ship Island, Horn Island, and east of Petit Bois Island to the Alabama state line (Appendix N). Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 6.2-19.4 ft deep (average 13.8 ft), with clean sand substrata (Appendix N).

An ongoing Mobile District Gulf sturgeon monitoring effort at Ship Island is being conducted by the USACE ERDC. The objective is to characterize the seasonal occurrences and movements of the sturgeon around Ship Island and within Camille Cut. In late spring 2011, a total of 21 receivers were placed around 3 areas (western tip of West Ship Island, Camille Cut, and eastern tip of East Ship Island) and monitored for Gulf sturgeon detections. No detections were documented during this period. The receivers were placed in the same locations in September 2011 and remained in place through June 2012. A total of 13,720 detections from approximately 14 Gulf sturgeon that originated from 5 rivers (Pearl, Pascagoula, Escambia, Blackwater, and Yellow) were found at all three sites. However, the largest number of detections was found along the eastern side of East Ship Island (ERDC, 2012). During the 2011–2012 monitoring period, the greatest number of sturgeon was detected in November, and numbers decreased each month (Appendix K).

During the third year of monitoring, eight additional receivers were placed in Dogs Keys Pass. From September 2012 through June 2013, 21 Gulf sturgeon (19 adult, 2 sub-adult) were detected. These sturgeon originated from the Pearl (6), Pascagoula (4), Escambia (1), Yellow (2), Brothers (4), Blackwater (3) and Choctawhatchee (1) Rivers. Overall, 94,244 detections were recorded during time period. This larger number than during the previous monitoring year may be attributed to the greater number of arrays (29 arrays) in 2012–2013 than in 2011–2012 (21 arrays). During the 2012–2013 monitoring period, the largest number of sturgeon was detected in December and decreased monthly (Appendix K).

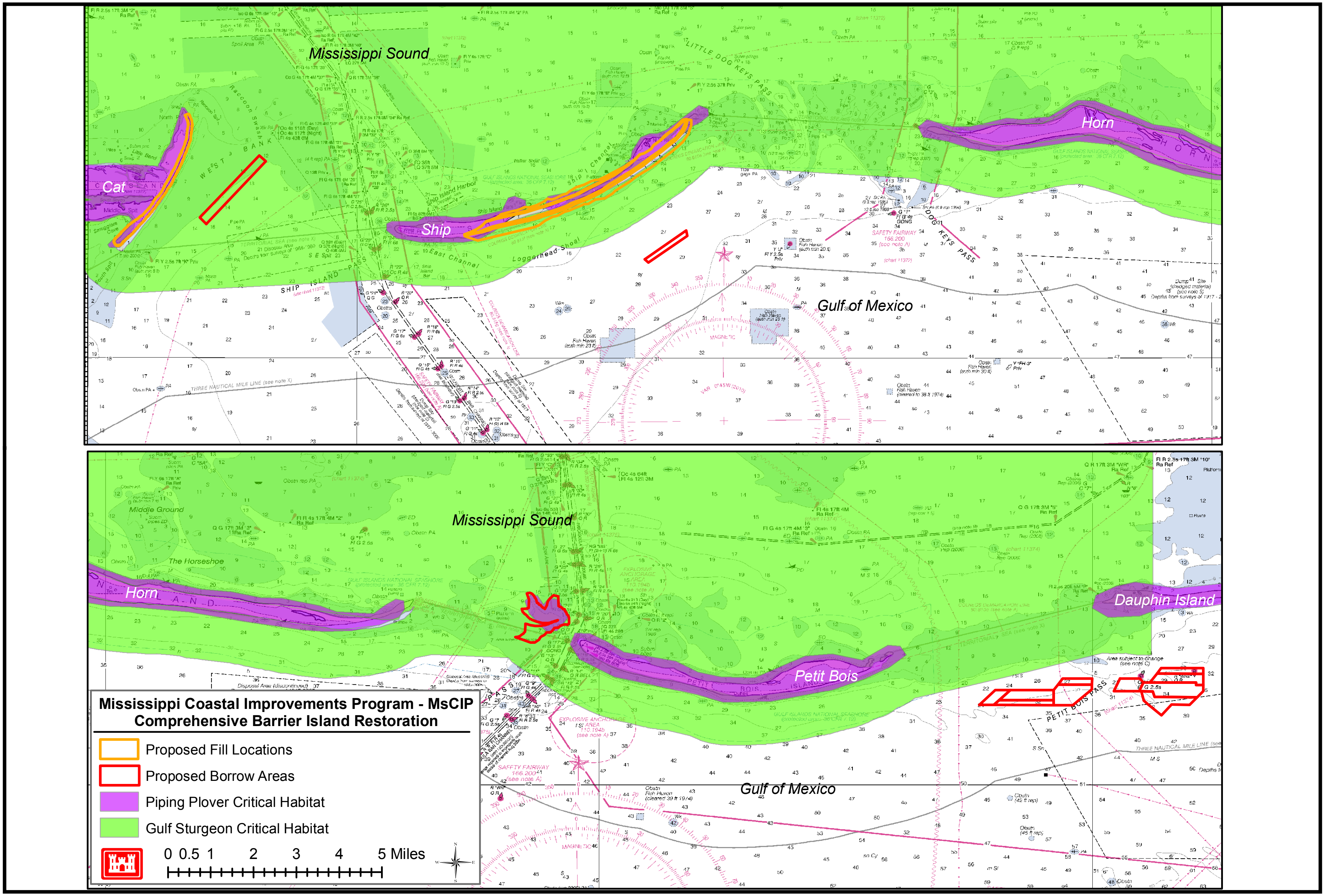

FIGURE 4-7
CRITICAL HABITAT BOUNDARIES
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

A summary of the 2012–2013 detections includes:

- West Ship Island—4 receivers; 2 percent of total detections; 11 Gulf sturgeon
- Camille Cut, Mississippi Sound side—9 receivers; 18 percent of total detections; 8 Gulf sturgeon
- Camille Cut, Gulf side—4 receivers; 6 percent of total detections; 11 Gulf sturgeon
- East Ship Island—4 receivers; 9 percent of total detections; 10 Gulf sturgeon
- Dog Keys Pass—8 receivers; 65 percent of total detections; 15 Gulf sturgeon

A study to identify benthic communities of Mississippi Sound and the Gulf of Mexico, with a focus at Mississippi barrier islands, was conducted during three sampling periods: June and September 2010 and May 2011. A total of 636 samples were collected, with taxa densities ranging from 257–10,206 individuals per square meter. Results show that the benthic community within the project area provides suitable forage habitat for adult and subadult fish. A wide variety of benthic invertebrates were found in the placement and borrow sites, including polychaetes, chordates, nemerteans, gastropods, amphipods, and bivalves, with polychaete worms dominating the majority of the sampling areas. However, taxa densities and richness were extremely variable between the sampling stations (Vittor and Associates, 2013). Additional benthic invertebrate sampling was conducted in October 2011 to support the evaluation of Gulf sturgeon habitat conditions in the project area (Appendix K).

ERDC (2012) correlated the Gulf sturgeon locations with the abundance of eight principal prey benthic species and identified a direct relationship between the number and detections of Gulf sturgeon and the availability of primary prey. The sturgeon were found more frequently in the areas with the higher abundance of principal prey species. Further, Camille Cut and the eastern side of Ship Island have relatively high overall abundances of these prey taxa compared to the west side of Ship Island (ERDC, 2012).

Gulf sturgeon occupy the coastal waters of Mississippi beginning in October or November to March. They move offshore, primarily to the barrier island passes, to feed (Appendix N; Ross et al., 2009). As discussed in the BA prepared for this SEIS (Appendix N), Gulf sturgeon move along the nearshore area at depths of 10 meters or less. A total of 71 tagged Gulf sturgeon were located in Mississippi Sound and the adjoining barrier islands over a 5-year study period (Ross et al., 2009). Winter telemetry locations of Gulf sturgeon from the Pascagoula and Pearl Rivers were primarily along the barrier islands, and only four fish were found north of the barrier islands and south of the West Pascagoula River mouth (Ross et al. 2009). The spatial distribution of Gulf sturgeon within the marine environment was strongly nonrandom, but was highly structured, and likely caused by the distribution of preferred prey taxa (Ross et al., 2009). Of the fish located in the barrier island region, 93 percent were found in the passes between the islands, including the two small passes between Ship Islands (Ross et al. 2009). The occurrence of Gulf sturgeon in the barrier island passes was consistent over the 5-year period of study (Ross et al., 2009).

Similarly, preliminary data by ERDC (2012) indicate that tagged sturgeon from five rivers, including the Pearl and Pascagoula Rivers, migrate from the rivers to the mainland shoreline, barrier islands, and passes in search of food. There are five passes within the Mississippi and Alabama barrier island chain, which include Ship Island Pass, Dog Keys Pass, Little Dog Keys Pass, Horn Island Pass, and Petit Bois Pass. These passes provide adequate shallow, sandy areas where Gulf sturgeon have been documented to congregate and feed (Appendix N; Ross et al., 2009). As noted previously, the area east of East Ship Island (Little Dog Keys Pass) and the Camille Cut had the overall higher abundances of Gulf sturgeon compared to the area west of Ship Island (Ship Island Pass) (ERDC, 2012). Multiple detections of these fish within the barrier island passes suggest that these are feeding areas (Appendix N; Ross et al., 2009; ERDC, 2012). Gulf sturgeon tagged in the Pascagoula and Pearl Rivers occupy the same marine feeding habitats (Ross et al., 2009).

4.5.8.3 Green Sea Turtle

The breeding populations of the green sea turtle off Florida and off the Pacific coast of Mexico are listed as endangered. All other breeding populations are listed as threatened (USFWS, 2010f). Although green sea turtles are found worldwide, this species is concentrated primarily between the 3º North and 35º South latitudes. Green sea turtles tend to occur in waters that remain warmer than 68ºF; however, there is evidence that they may be buried under mud in a torpid state in waters to 50ºF (Ehrhart, 1977; Carr et al., 1979). In the southeastern U.S., nesting season is approximately June through September. Nesting occurs nocturnally at 2-, 3-, or 4-year intervals. The turtles are not known to nest on the Mississippi coast or barrier islands, but have been found feeding in the seagrass beds in nearshore waters. Nesting has occurred in Alabama, and therefore it could occur in Mississippi.

Only occasionally do females produce clutches in successive years. Estimates of age at sexual maturity range from 20–50 years (Balazs, 1982; Frazer and Ehrhart, 1985), and they may live over 100 years. Immediately after hatching, green turtles swim past the surf and other shoreline obstructions, primarily at depths of about 8 inches or less below the water surface, and are dispersed both by vigorous swimming and surface currents (Balazs, 1980). The whereabouts of hatchlings to juvenile size is uncertain. Green turtles tracked in Texas waters spent more time on the surface, with less submergence at night than during the day, and a very small percentage of the time was spent in the federally maintained navigation channels. The tracked turtles tended to utilize jetties, particularly outside of them, for foraging habitat (Renaud and Carpenter, 1994).

4.5.8.4 Kemp’s Ridley Sea Turtle

The Kemp’s ridley sea turtle is listed as endangered under the ESA (USFWS, 2010g). The Kemp’s ridley occurs mainly in coastal areas of the Gulf of Mexico and the northwestern Atlantic Ocean, with occasional individuals reaching European waters. Immature turtles have been found along the eastern seaboard of the U.S. and in the Gulf of Mexico, including Mississippi Sound. In the Gulf, studies suggest that immature turtles stay in shallow, warm, nearshore waters in the northern Gulf until cooling waters force them offshore or south along the Florida coast (Renaud, 1995). Little is known of the movements of the post-hatching stage (pelagic stage) within the Gulf. Studies have indicated that this stage varies from 1–4 or more years and the immature stage lasts about 7–9 years (Schmid and Witzell, 1997). The maturity age of this species is estimated to be 7–15 years.

Kemp’s ridley sea turtles are regularly seen in Mississippi Sound, and although no nesting has been documented, they could potentially nest on the Mississippi barrier islands. Immature Kemp’s ridley turtles have been incidentally captured by recreational fishermen at Mississippi fishing piers. In 2012, almost 200 Kemp’s ridley turtles were captured and rehabilitated (Coleman, personal comm., 2012). Nests have been documented on Santa Rosa Island in the Florida District of the GUIS along the Gulf coast. In addition, nesting is being reestablished in Texas through conservation programs; however, its primary nesting area is near Rancho Nuevo in Tamaulipas, Mexico (Rothschild, 2004).

4.5.8.5 Loggerhead Sea Turtle

The loggerhead sea turtle is currently listed as endangered by USFWS and threatened by NOAA Fisheries. Loggerhead sea turtles occur throughout the temperate and tropical regions of the Atlantic, Gulf of Mexico, Pacific, and Indian Oceans. This species may be found hundreds of miles out to sea, as well as in inshore areas such as bays, lagoons, salt marshes, creeks, and the mouths of large rivers.

Nesting in the northern Gulf outside of Florida occurs primarily on the Chandeleur Islands in Louisiana and to a lesser extent on adjacent Ship, Horn, and Petit Bois Islands in Mississippi (Ogren, 1977). Ogren (1977) reported a historical reproductive assemblage of sea turtles, which nested seasonally on remote barrier beaches of eastern Louisiana, Mississippi, and Alabama. These sea turtles have historically nested on Mississippi's barrier islands (e.g., Ship, Horn, and Petit Bois) about 19 km south of the mainland (Appendix N). More recent occurrences of sea turtles nesting on the Mississippi barrier islands have been documented by the NPS. From 1990- 2011, loggerhead sea turtle nesting and/or false crawls have been documented at several barrier islands (Cat, West and East Ship, Horn, and Petit Bois). Among the barrier islands, most of the nesting occurred on Petit Bois and Horn Islands, with few nests documented on the other islands. There was one nest documented on East Ship Island (1992), two nests on Cat Island (1998), 16 nests on Horn Island (1998), and 12 nests on Petit Bois Island (1998). For the 2012 nesting season, there were several documented nests on East, and West Ship Island and Cat Island. A total of four nests were documented on West Ship Island, including three on the southern shoreline and one on the northern shoreline (Hopkins, personal comm., 2012). A total of three nests were observed by Hopkins on the southern shoreline of East Ship Island. There were three confirmed nests and one potential nest on Cat Island (Necaise, personal comm., 2012). In addition, four confirmed nests were reported on the Mississippi mainland, including one on Deer Island (Coleman, personal comm., 2012) and several on Petit Bois and Horn Islands. As of July 2013, there have been two confirmed loggerhead nests during the 2013 nesting season. One nest was observed on the north shore of West Ship Island (Williams, personal comm., 2013), and one nest was observed on the Mississippi mainland (Coleman, personal comm., 2013).

There is currently no designated critical habitat for the loggerhead sea turtle in the project area. However, the USFWS has begun the process of identifying coastal beach habitat that is important for the recovery of the NW Atlantic population of the loggerhead sea turtle. The agency has identified portions of islands and mainland coastal beaches in six states, including Mississippi and Alabama, to propose as critical habitat. The areas within Mississippi include Horn and Petit Bois Islands, and in Alabama Little Lagoon Pass, Gulf State Park, and Perdido Pass. Currently the USFWS is seeking public comment via the Fed. Reg. Efforts are also underway by NMFS, Gulf Coast Community Protection and Recovery District, to designate critical habitat for the loggerhead sea turtle in the project area.

4.5.8.6 Hawksbill Sea Turtle

The hawksbill sea turtle is the second smallest sea turtle and is somewhat larger than the Kemp's ridley. The hawksbill sea turtle is small to medium size, with a very elaborately colored shell of thick overlapping scales. The overlapping carapace scales are often streaked and marbled with amber, yellow, or brown. Hawksbill turtles have a distinct, hawks-like beak. The name of the turtle is derived from the tapered beak and narrow head.

Hawksbill sea turtles are a highly migratory species. These turtles generally live most of their life in tropical waters, such as the warmer parts of the Atlantic Ocean, Gulf of Mexico, and the Caribbean Sea (Appendix N). Florida and Texas are the only states where hawksbills are sighted with any regularity (NMFS and USFWS, 1993). Juvenile hawksbills are normally found in waters less than 45 ft in depth. They are primarily found in areas around coral reefs, shoals, lagoons, lagoon channels, and bays with marine vegetation that provides both protection and plant and animal food. Unlike the green turtles, hawksbills can tolerate muddy bottoms with sparse vegetation. They are rarely seen in Louisiana, Alabama, and Mississippi waters.

Hawksbills nest throughout their range, but most of the nesting occurs on restricted beaches, to which they return each time they nest. These turtles are some of the most solitary nesters of all the sea turtles. Depending on location, nesting may occur from April through November (Appendix N). Hawksbills prefer to nest on clean beaches with greater oceanic exposure than those preferred by green sea turtles, although they are often found together on the same beach. The nesting sites are usually on beaches with a fine gravel texture. Hawksbills have been found in a variety of beach habitats ranging from pocket beaches only several yards wide formed between rock crevices to a low-energy sand beach with woody vegetation near the waterline. These turtles tend to use nesting sites where vegetation is close to the water's edge.

4.5.8.7 Leatherback Sea Turtle

The leatherback sea turtles are the largest of all sea turtles. These turtles may reach a length of about 7 ft and weigh as much as 1,600 pounds. The carapace is smooth and gray, green, brown, and black. The plastron is yellowish white. Juveniles are black on top and white on the bottom. This species is highly migratory and is the most pelagic of all sea turtles (NMFS and USFWS, 1992). They are commonly found along continental shelf waters (Appendix N). Leatherback sea turtles' range extends from Cape Sable, Nova Scotia, south to Puerto Rico and the U.S. Virgin Islands. Leatherbacks are found in temperate waters while migrating to tropical waters to nest (Ross, 1981). The distribution of this species has been linked to thermal preference and seasonal fluctuations in the Gulf Stream and other warm water features (Fritts et al., 1983). The general decline of this species is attributed to exploitation of eggs (Ross, 1981).

Leatherback sea turtles are omnivorous. They feed mainly on pelagic soft-bodied invertebrates, such as jellyfish and tunicates. Their diet may also include squid, fish, crustaceans, algae, and floating seaweed. Highest concentrations of these prey animals are often found in upwelling areas or where ocean currents converge.

Nesting of leatherback sea turtles is nocturnal, with only a small number of nests occurring in the Florida portion of the Gulf of Mexico from April to late July (Appendix N). There is very little nesting in the U. S except in the western Atlantic, where leatherback and hawksbill primarily nest at sites in the Caribbean, with isolated nesting on Florida beaches (Gunter, 1981; Rothschild, 2004). However, leatherback sea turtles have been occasionally seen feeding in the drift lines of jellyfish in Mississippi Sound and the Gulf waters surrounding the Mississippi barrier islands (Hopkins, personal comm., 2012).

Leatherback sea turtles prefer open access beaches, possibly to avoid damage to their soft plastron and flippers. Unfortunately, such open beaches with little shoreline protection are vulnerable to beach erosion triggered by seasonal changes in wind and wave direction. Thus, eggs may be lost when open beaches undergo severe and dramatic erosion. The Pacific coast of Mexico supports the world's largest known concentration of nesting leatherbacks.

4.5.8.8 Piping Plover and Piping Plover Critical Habitat

Different distinct population segments of the piping plover are listed as endangered or threatened under the ESA (USFWS, 2010h). Piping plover critical habitat in and near the project area is shown on Figure 4-7. The project area is located within piping plover critical habitat, Mississippi Unit 14. The final rule designating critical habitat for the wintering population of the piping plover was published in the Fed. Reg. on July 10, 2001. The primary constituent elements for the piping plover wintering habitat are those habitat components that are essential for the primary biological needs of foraging, sheltering, and roosting, and only those areas containing these primary constituent elements within the designated boundaries are considered critical habitat. The primary constituent elements are found in geologically dynamic coastal areas that support or have the potential to support the species, such as intertidal beaches and flats and the sparsely vegetated back beach areas. Important components of intertidal flats include sand and/or mud flats with no or sparse emergent vegetation. Critical habitat for Mississippi Unit 14 extends to the MLLW.

Surveys for piping plovers on Mississippi barrier islands and mainland beaches indicate a midwinter period when most of the birds are winter residents and a spring-fall migration when many more birds move through the islands, staying for only a short time. During the migration, these areas serve as refueling spots on the long migratory journey. Within the project area, piping plovers are known to congregate primarily along the tidal flats and tips of West and East Ship Islands and at Petit Bois, Horn, Cat Islands. In a survey for the 2009 migratory period, approximately 24–34 piping plovers on Petit Bois, Horn, and West and East Ship Islands (Zdravkovic, 2009) were counted. However, higher numbers of plovers were observed for Cat, West, and East Ship Islands during the 2010–2011 migratory period (Necaise, person comm., 2012).

During the 2008–09 wintering period, piping plovers were surveyed from Boca Chica, Texas to Marco Island, Florida (Maddock, 2010). Over a 9-day period, the Mississippi mainland and barrier islands were observed. A maximum of 41 birds were observed on Cat Island, 24 on East Ship, 25 on West Ship, 29 on Horn, and 14 on Petit Bois. Moderate numbers of piping plovers were counted on the mainland beaches. Maddock observed higher frequencies of plover use on areas that had large exposed flats, overwash areas, or newly created inlets.

In a 2011 wintering survey, the majority of birds were recorded at East Ship, Cat, and Horn Islands; and of the three, Cat Island had the most, with 45 birds (Winstead, personal comm., 2012). In addition, a 2012 survey noted at least 38 piping plovers on Cat Island, 55 on East Ship Island, 15 on Petit Bois, 3 on West Ship Island, and 32 on Horn Island (Winstead, personal comm., 2012). During bird surveys conducted in support of the MsCIP barrier island restoration project between December 28, 2012 and December 18, 2013 (Appendix J), a total of 1,154 piping plovers were observed in the project area. Piping plover were observed on DA-10/Sand Island (17), East Ship Island (779), and West Ship Island (358). Figures in Appendix J show the number of piping plover observed monthly at each of the survey locations. On East Ship Island, the largest number of piping plover was observed during the month of October (416 birds). Relatively large numbers of piping plovers were observed on East Ship Island during the months August through December, while relatively large numbers were observed on West Ship Island during the months January through April. On Sand Island, the month of February had the largest number (12) of piping plovers, and all other months had much lower numbers of this species.

4.5.8.9 Red Knot

The red knot (*Calidris cantus*) is a sandpiper shorebird species of concern that has been observed wintering on the majority of the barrier islands, especially Cat and Petit Bois Islands, in few numbers. The USFWS proposed to list one subspecies, the rufa red knot (*Calidris canutus rufa*), as a threatened species under the ESA (USFWS, 2013). *C. canutus rufa* breed in the central Canadian Arctic and most winter in Tierra del Fuego, Maranhão, or Florida (New Jersey Dept. of Env. Protection, 2007). The USFWS lists Mississippi and Alabama as states where *C. canutus rufa* are known or believed to occur. However, a county-level range has not been defined for Mississippi or Alabama. The USFWS Species Action Plan for *C. canutus rufa* does not include the Mississippi or Alabama coastline in wintering or stopover paths of C. c*anutus rufa* (USFWS, 2010i).

Bird surveys, conducted in support of the MsCIP barrier island restoration project during the period December 28, 2012 and December 18, 2013, identified a total of 292 red knots in the project area. Figures in Appendix J show the number of red knot observed monthly at each of the survey locations. Red knots were observed on DA-10/Sand Island (11), East Ship Island (265), and West Ship Island (16) (Appendix J). Most red knots were observed in January 2013 (75) and May 2013 (61).

4.6 Essential Fish Habitat

The Magnuson Fisheries Conservation and Management Act of 1976 (the Act) was passed to promote sustainable fish conservation and management. Under the Act, NOAA Fisheries was granted legislative authority for fisheries regulation in the U.S. within a jurisdictional area located between 3 miles and 200 miles offshore, in the Exclusive Economic Zone depending on geographic location. NOAA Fisheries was also granted legislative authority to establish eight regional fishery management councils responsible for the proper management and harvest of fish and shellfish resources within these waters. Measures to ensure the proper management and harvest of fish and shellfish resources within these waters are outlined in Fisheries Management Plans prepared by the eight councils for their respective geographic regions. The Mississippi Sound system and nearshore Gulf of Mexico are within the management jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC).

NOAA Fisheries recognized that many marine fisheries are dependent on nearshore and estuarine environments for at least part of their life cycles. The Act was reauthorized and changed extensively via amendments in 1996 (P.L. 104-297), stressing the importance of habitat protection to healthy fisheries. The authority of NOAA Fisheries and its councils was strengthened by the reauthorization to promote more effective habitat management and protection of marine fisheries. Specific marine environments important to marine fisheries are referred to as EFH in the Act and are defined as those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity (16 U.S. Code [U.S.C.] § 1802 (10)).

The EFH regulations (at 50 C.F.R. § 600 Subpart J) provide additional interpretation of the definition of EFH: waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fishes and may include areas historically used by fishes. Substrate includes sediment, hardbottom, structures underlying the waters, and any associated biological communities. "Necessary" means the habitat required to support a sustainable fishery and the managed species' contribution to a healthy ecosystem. Spawning, breeding, feeding, or growth to maturity covers all habitat types used by a species throughout its life cycle. Figures showing EFH in the project area are presented in Appendix O.

4.6.1 Species Accounts

Three key sources (GMFMC, 1998, 2004, 2005) were used to describe the life history and preferred habitat of managed species with EFH designated within the area encompassed by all the restoration alternatives considered. Relative abundance information was obtained from Estuarine Living Marine Resources database (NOAA; http://ccma.nos.noaa.gov/ecosystems/estuaries/elmr.aspx).

4.6.1.1 Red Drum Fishery

The red drum occurs throughout the Gulf of Mexico in a variety of habitats, ranging from depths of about 40 meters (130 feet) offshore to very shallow estuarine waters. Red drum commonly occur in most Gulf estuaries where they are found over a variety of substrates, including seagrass, sand, mud, and oyster reefs. Spawning occurs in deeper water near the mouths of bays and inlets, and on the Gulf side of the barrier islands (Pearson, 1929; Simmons and Breuer, 1962; Perret et al., 1980) from about September through November. Red drum are known to spawn in depths ranging from a minimum of 40 meters to a maximum of 70 meters (130–230 feet) (NOAA Fisheries, 2004a). The eggs hatch mainly in the Gulf, and larvae are transported into the estuary where the fish mature before moving back to the Gulf (Perret et al., 1980; Pattillo et al., 1997). Known nursery areas in the western Gulf of Mexico are Lake Pontchartrain and Mobile Bay (NOAA, 2010b). Estuarine wetlands are especially important to larval, juvenile, and subadult red drum. An abundance of juvenile red drum has been reported around the perimeter of marshes in estuaries (Perret et al., 1980). Young fish were found in quiet, shallow, protected waters with grassy or slightly muddy bottoms (Simmons and Breuer, 1962). Shallow bay bottoms or oyster reef substrates were especially preferred by subadult and adult red drum (Miles, 1950). Adult red drum use estuaries but tend to spend more time offshore as they age.

Larval red drum feed almost exclusively on mysids, amphipods, and shrimp, whereas larger juveniles feed more on crabs and fish (Peters and McMichael, 1987). Overall, crustaceans and fishes are most important in the diet of red drum; primary food items are blue crabs, striped mullet, spot, pinfish, and pigfish.

In Mississippi Sound, juvenile red drum are relatively common year-round, and adults are relatively common from February to October.

4.6.1.2 Shrimp Fishery

Brown, white, and pink shrimp occur throughout Mississippi Sound. A description of the life histories of the three shrimp species and their seasonal movements is presented in Section 4.5.3.

4.6.1.3 Stone Crab Fishery

Florida stone crab (*Menippe mercenaria)* and Gulf stone crab (*M. adina*) comprise the stone crab fishery in the Gulf of Mexico. The Gulf stone crab is typically smaller than the Florida stone crab and replaces it in the northern and western Gulf of Mexico (northwest Florida to Tamaulipas, Mexico). Adult stone crabs are benthic organisms and can be found from the shoreline out to depths of 61 meters (200 feet). They occupy a variety of habitats, including burrows under rock ledges, coral heads, dead shell, and seagrass patches. Adults also inhabit oyster bars and rock jetties and are commonly found on artificial reefs where adequate refugia are present. Stone crabs spawn principally from April through September.

Juveniles are also benthic but do not burrow; they use readily available refugia in proximity to food items. Juveniles can be found on shell bottom, sponges, and *Sargassum* mats as well as in channels and deep grass flats. After reaching a width of about 0.5 inch, the crabs live within oyster beds and rocks in shallow parts of estuaries. There are numerous reports of large juveniles to small adults being abundant on oyster reefs (Florida Marine Research Institute, 2001). Adults and juveniles appear to be hardy, can tolerate most environmental extremes within their distribution range, and are capable of surviving salinities considerably higher or lower than 33 ppt. Stone crab larvae are planktonic and require warm water 30°C (86°F) and high salinity (30–35 ppt) for most rapid growth (Lindberg and Marshall, 1984).

The stone crab is a high trophic level predator and is primarily carnivorous at all lifestages. Juveniles feed on small mollusks, polychaetes, and crustaceans. Adults consume several species of mollusks, including oysters and mussels, and also consume carrion and vegetable matter such as seagrass (Lindberg and Marshall, 1984).

Adult and juvenile stone crabs are relatively common in most of Mississippi Sound year-round.

4.6.1.4 Reef Fishery

Gray snapper occur in estuaries and shelf waters of the Gulf and are particularly abundant off south and southwest Florida. Considered to be one of the more abundant snappers inshore, the gray snapper inhabits waters to depths of about 180 meters (590 feet). Adults are demersal and mid-water dwellers, occurring in marine, estuarine, and riverine habitats. They occur up to 32 kilometers (20 miles) offshore and inshore as far as Coastal Plain freshwater creeks and rivers. They are found among mangroves, sandy grassbeds, and coral reefs and over sandy, muddy, and rocky bottoms. Spawning occurs offshore around reefs and shoals from June to August. Eggs are pelagic, and are present from June through September after the summer spawn, occurring in offshore shelf waters and near coral reefs. Larvae are planktonic, occurring in peak abundance from June through August in offshore shelf waters and near coral reefs from Florida through Texas. Post-larvae move into estuarine habitat and are found especially over dense grass beds of *Halodule* and *Syringodium*. Juveniles are marine, estuarine, and riverine dwellers, often found in estuaries, channels, bayous, ponds, grassbeds, marshes, mangrove swamps, and freshwater creeks. They appear to prefer *Thalassia* grass flats, marl bottoms, seagrass meadows, and mangrove roots. Juveniles utilize the estuarine bays as nursery grounds from May through September.

Gray triggerfish are found throughout the Gulf of Mexico. Eggs are deposited in late spring and summer in nests prepared in sand near natural and artificial reefs. Larvae and post-larvae are pelagic, occurring in the upper water column, usually associated with *Sargassum* and other flotsam. Early and late juveniles also are associated with *Sargassum* and other flotsam, and may be found in mangrove estuaries. Triggerfish leave the surface *Sargassum* habitat in the fall, when juvenile fish (5-7 inches) move to reef habitat on the bottom. Adults are found offshore in waters deeper than 10 meters (33 feet) where they are associated with natural and artificial reefs. Triggerfish may move away from the reef structure in order to feed. Spawning adults occur in late spring and summer, also around natural and artificial reefs in water depths greater than 10 meters (33 feet).

Lane snapper occur throughout the shelf area of the Gulf in depths ranging from 0-130 meters (0-427 feet). The species is demersal, occurring over all bottom types, but is most common in coral reef areas and sandy bottoms. Spawning occurs in offshore waters from March through September. Nursery areas include mangrove and grassy estuarine areas in southern Texas and Florida and shallow areas with sandy and muddy bottoms off of all the Gulf States. Early and late juveniles appear to favor grass flats, reefs, and soft bottom areas to offshore depths of 20 meters (66 feet) (NOAA, 1985). Adults occur offshore at depths of 4-132 meters (13–433 feet) on sand bottom, natural channels, banks, and man-made reefs and structures.

Red snapper occur throughout the Gulf of Mexico shelf. They are particularly abundant on the Campeche Banks and in the northern Gulf. The species is demersal and is found over sandy and rocky bottoms, around reefs, and around underwater objects from shallow water to 200 meters (656 feet). Adults favor deeper water in the northern Gulf. Spawning occurs in offshore waters from May to October at depths of 18–37 meters (59–121 feet) over fine sand bottom away from reefs. Eggs are found offshore in summer and fall. Larvae, post-larvae, and early juveniles are found from July through November in shelf waters ranging in depth of 17–183 meters (55–600 feet). Early and late juveniles are often associated with structures, objects, or small burrows, but also are abundant over barren sand and mud bottoms. Late juveniles are caught year-round at depths of 20–46 meters (65–130 feet).

4.6.1.5 Coastal Pelagic Fishery

In the Gulf of Mexico, cobia are found in coastal and offshore waters (from bays and inlets to the continental shelf) from depths of 1–70 meters (3–230 feet). Adults feed on fishes and crustaceans, including crabs. Spawning occurs in coastal waters from April through September at temperatures ranging from 23–28°C (73.4–82.4°F). These fish migrate seasonally, and are commonly seen among other species in the family. Eggs are found in the top meter of the water column, drifting with the currents. Larvae are typically found in offshore waters of the northern Gulf of Mexico, where they likely feed on zooplankton. Juveniles occur in coastal and offshore waters, feeding on small fishes, squid, and shrimp.

King mackerel occur in the Gulf of Mexico, with centers of distribution in south Florida and Louisiana. Adults are found over reefs and in coastal waters, although they rarely enter estuaries. Migrations to the northern Gulf in the spring are believed to be temperature-dependent, and the species is found in waters with temperatures greater than 20°C (68°F). Although adults can be found at the shelf edge in depths to 200 meters (656 feet), they generally occur at depths less than 80 meters (262.5 feet) and at oceanic salinities from 32-36 ppt. Adults feed mostly on fishes, and less often on crustaceans and mollusks, with a diet that includes jacks, snappers, grunts, halfbeaks, penaeid shrimp, and squid. Adults spawn over the OCS from May to October, with the northwestern and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found offshore over depths of 35–180 meters (115–591 feet) in spring and summer. Larvae occur over the middle and OCS, principally in the north-central and northwestern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. Juveniles are found from inshore to the middle shelf, where they feed on engraulid and clupeid fishes and some squid.

Spanish mackerel occur in the Gulf of Mexico, with their center of distribution off the Florida coast. Adults are found in inshore coastal waters, and may enter estuaries in pursuit of baitfish. Migrations to the northern Gulf in the spring are believed to be temperature-dependent, and the species is found in waters with temperatures greater than 20°C (68°F) and out to depths of 75 meters (246 feet) at oceanic salinities. Adults feed mostly on fishes, and less often on crustaceans and mollusks, with a diet that includes clupeids, engraulids, carangids, and squid. Adults spawn over the inner continental shelf from May to September, with the north-central and northeastern Gulf of Mexico considered important spawning areas. The pelagic eggs are found over the inner continental shelf at depths less than 50 meters (164 feet) in spring and summer. Larvae occur over the inner continental shelf, principally in the northern Gulf, where they consume larval fishes such as carangids, clupeids, and engraulids. Juveniles occur in estuarine and coastal waters, where they feed on engraulid and clupeid fishes, gastropods, and some squid. Juveniles are relatively common in Mississippi Sound from spring through fall.

4.6.1.6 Highly Migratory Species

Mississippi Sound and adjacent waters have been identified as important nursery areas for nine shark species, primarily Atlantic sharpnose (*Rhizoprionodon terraenovae*), blacktip (*Carcharhinus limbatus*), finetooth (*Carcharhinus isodon*), and bull sharks (*Carcharhinus leucas*). Other less common species are the spinner (*Carcharhinus brevipinna*), blacknose (*Carcharhinus acronotus*), sandbar (*Carcharhinus plumbeus*), bonnethead (*Sphyrna tiburo*), and scalloped hammerhead (*Sphyrna lewini*). EFH has been identified in this area for the blacknose, Atlantic sharpnose, bonnethead, tiger (*Galeocerdo cuvier*), spinner, bull, blacktip, and scalloped hammerhead sharks.

Typically sharks migrate inshore in the early spring around March and April, remain inshore during the summer months, and then migrate offshore around October. Most shark species in the Mississippi coastal waters give birth during late spring and early summer, with young sharks spending just a few months of their lives in shallow coastal waters.

Most shark species are abundant around barrier islands, with adult sharks commonly present south of the barrier islands. Younger sharks, which can tolerate lower salinities, have been found as far inshore as Round and Deer Islands.

The four most common inshore shark species feed primarily on fish, including menhaden, spot, croaker, speckled trout, and hardhead catfish. In addition, researchers have found crabs in the stomachs of bonnethead shark and stingrays and smaller sharks in the stomachs of blacktip and bull sharks.

4.7 Special Aquatic Sites

Special aquatic sites include marine sanctuaries and protected coastal marsh areas.

The National Marine Sanctuary System consists of 14 marine protected areas (MPAs) that range from less than 1 square mile to 137,792 square miles of ocean and Great Lakes waters (NOAA, 2010b). Two national marine sanctuaries are located in the Gulf; however, both are far from the project area. The Flower Garden Banks National Marine Sanctuary is located in the western part of the Gulf, 75–120 miles off the coasts of Texas and Louisiana. The Florida Keys National Marine Sanctuary is located off the southern tip of Florida (NOAA, 2010b).

The project area is bordered by two large marsh systems along the Mississippi mainland coast. The Grand Bay Marshes to the east lie within the 18,000-acre Grand Bay NERR in Jackson County (USACE, 2009a). Other important marsh areas are the Grand Bay National Wildlife Refuge in Jackson County and the Hancock County Marshes.

4.8 Cultural Resources

This section presents information on cultural resources located in the project area. The discussion includes a description of regulatory requirements, methods used to identify existing archaeological and architectural resources, and the number and types of archaeological and architectural resources known or expected to occur within the project area and the number of archaeological and architectural resources that are listed in or eligible for listing in the NRHP.

For NPS management purposes, cultural resources are identified as archaeological resources, cultural landscapes, structures, museum objects, and ethnographic resources. Cultural resources are discussed in terms of archaeological sites, which include both prehistoric and historical occupations either submerged or on land, and architectural resources. Archaeological sites can become submerged when they are inundated following impoundment of rivers, and shipwrecks are a specific type of submerged archaeological site (NPS, 2010b).

Federal projects are subject to a number of federal laws and regulations regarding cultural resources: NEPA, Antiquities Act of 1906, Archaeological and Historic Preservation Act of 1974, Archaeological Resources Protection Act of 1979, Abandoned Shipwreck Act of 1987, Native American Graves Protection and Repatriation Act (NAGPRA), Section 106 of the National Historic Preservation Act of 1966 (NHPA) (36 C.F.R. § 800), and Protection of Archaeological Resources (43 C.F.R. § 7), as well as executive orders. Guidance issued by the NPS in Bulletin Number 20 (Delgado, 1997) highlights consultation with the State Historic Preservation Officer (SHPO) regarding shipwrecks. Furthermore, 43 U.S.C. § 2105 supports transfer of title for qualifying Abandoned Shipwrecks to State Governments, “The title of the United States to any abandoned shipwreck asserted under subsection (a) of this section is transferred to the State in or on whose submerged lands the shipwreck is located.”

Section 106 of the NHPA, as amended (16 U.S.C. § 470), governs Federal actions that could affect cultural resources. Section 106 requires Federal agencies to take into account the effects of their undertakings on cultural resources and to afford the Advisory Council on Historic Preservation (ACHP) and other interested parties a reasonable opportunity to comment. Section 101(b)(4) of NEPA requires Federal agencies to coordinate and plan their actions so as to preserve important historic, cultural, and natural aspects of the country's national heritage.

As defined broadly by the regulations implementing Section 106 (36 C.F.R. § 800), historic property is defined as any prehistoric or historic district, site, building, structure, or object included in, or eligible for inclusion in, the NRHP. The criteria for NRHP eligibility are set forth in Title 36 of C.F.R. § 60.4 as follows:

> *The quality of significance in American history, architecture, archaeology, engineering, and culture is present in districts, sites, building, structures, landscapes, and objects that possess integrity of location, design, setting, materials, workmanship, feeling, and association." and:*
>
> A. *That are associated with events that have made a significant contribution to the broad patterns of our history; or*
>
> B. *That are associated with the lives of persons significant in our past; or*
>
> C. *That embody the distinctive characteristics of a type, period, or method of construction, or that represent the work of a master, or that possess high artistic values, or that represent a significant and distinguishable entity whose components may lack individual distinction; or*
>
> D. *That has yielded, or may be likely to yield, information important in prehistory or history.*

In addition, to qualify for listing in the NRHP, a resource usually must be at least 50 years old, with stipulated exceptions under Criteria Consideration G for properties that have not reached that threshold. Properties that qualify for listing in the NRHP also must possess aspects or qualities of integrity, defined by the following categories: location, design setting, materials, workmanship, feeling, and association (NPS, 2000:36).

In accordance with the recommendations in Chapter 4 of the MsCIP PEIS (USACE, 2009a) and the NHPA, USACE will proceed with Section 106 consultation on the barrier island restoration project with the SHPO, interested tribes, and other consulting parties regarding the following: project Area of Potential Effects (APE), cultural resources inventory strategies, NRHP eligibility, and project effects.

4.8.1 Cultural Context

Information regarding the past cultural chronology in the region is used in the assessment of archaeological potential, and provides an interpretive context for any potential archaeological or other cultural resources in the project area. Knowledge of local prehistory and history helps to place cultural resources within their historical context and is necessary for evaluating the importance of cultural resources within the APE.

The project area encompasses several barrier islands in Mississippi. The MsCIP PEIS (USACE, 2009a) provides a brief overview of the context for prehistoric and historic periods.

The prehistoric occupation of the coastal Mississippi region is delineated by archaeologists into five major periods: the Paleo-Indian, Archaic, Gulf Formational, Woodland, and Mississippian periods. The majority of the prehistoric resources identified in the region have been found along rivers (particularly the mouths of rivers) and on the barrier islands. Most surveys during which these sites were identified were conducted at limited locations, so they cannot predict the probability or certainty of other sites in the area (USACE, 2009a).

Explorers, particularly of French origin, began to arrive in the area in the mid- to late 17th century. The French established the first settlement in the region in 1699 at Old Biloxi, which is now Ocean Springs. The territory changed hands between the French, English, and

Spanish between 1763 and the Louisiana Purchase in 1812, when it became part of the United States. The early French settlements began along the local bays, rivers, and other waterways and grew into prosperous ports. The economy of the region was centered around agriculture, timber, charcoal, commercial fishing, and oyster and shrimp processing. Later in the 19th century, the economy also included resort destinations and tourism (USACE, 2009a).

Ship Island served as a major port for explorers and colonists and received its name from the deep harbor on the north side of the island where large ships could anchor. In 1847, the island was named a military reservation. Construction of what is now called Fort Massachusetts began in 1859 and was mostly completed by 1866. Before the fort was complete, a lighthouse was built on the island, but was destroyed early in the Civil War. The lighthouse was replaced in 1862 and underwent various upgrades and additions throughout the early 20th century. In 1969, Hurricane Camille damaged the lighthouse. The lighthouse was rebuilt on its historic foundation in 1999, but was destroyed by Hurricane Katrina in 2005 (USACE, 2010b; NPS, 2010b). Remnants of the lighthouse and foundation remain in the swash zone.

4.8.2 Cultural Resources within the Project Area

Research into the cultural resources located within the project area focused mainly on properties identified in reports published over the last 5 years. These reports were used to locate cultural resources previously identified through cultural resources investigations; no new surveys were conducted and no new research was carried out. It is customary not to publish the locations of archaeological sites due to their cultural sensitivity and risk of looting or disruption, so the exact locations of the sites listed are not known at this time. Table 4-8 summarizes the cultural resources identified during previous investigations in the area.

TABLE 4-8
Summary of Previously Identified Cultural Resources

Resource Name	Resource Type	Location	NRHP Status
Wreck of the *Josephine* (22HR843)	Shipwreck	Off the Coast of Biloxi, Mississippi	Listed 2000
Gulf Island National Seashore	National Park	Mississippi and Florida Coasts	NA
Fort Massachusetts (22HR641)	Standing Structure	West Ship Island	Listed 1971
French Warehouse (22HR0638)	Archaeological Site	East Ship Island	Listed 1991
22HR639	Quarantine Station	East Ship Island	Unknown
Ship Island Lighthouse (22HR640)	Archaeological Site	East Ship Island	Unknown

Types of cultural resources that could be found in the project area include sunken shipwrecks, marine archaeology, and standing structures, particularly forts or other military and marine associated structures. Marine archaeological sites in the area could include prehistoric middens, remnants of historic structures, as well as ballast, cannons and cannon balls, and pottery shards. Traditional cultural properties can also be significant due to their traditional religious or cultural importance to a tribe or other established community. According to the PEIS, the potential for identifying additional buried archaeological sites and submerged historic shipwrecks in the project area is considered high, based on the number of known resources (USACE, 2009a).

Shipwrecks could include those from the earliest period of exploration of the Americas and the southern United States to modern times, including those from Hurricane Katrina in 2005. To be eligible for listing in the NRHP, a vessel must have significance as one of five basic types of historic vessels: floating, dry-berthed, small craft, hulk, or shipwreck. Shipwrecks are defined as a submerged or buried vessel that has been foundered, stranded, or wrecked and includes vessels that are intact or scattered components on or in the sea bed, lake bed, mud flats, beaches, or other shorelines, excepting hulks (NPS, 1992). As with other cultural resources, to be NRHP-eligible, the vessel must also retain the seven aspects of integrity.

Previous cultural resources investigations in the three southern counties for the MsCIP PEIS (USACE 2009a) identified eight shipwrecks in that project area. No shipwrecks were identified in Hancock County, seven in Harrison County, and one in Jackson County. One of these in Harrison County is listed in the NRHP (the *Josephine*) and the others have no NRHP eligibility recommendations. From available materials, the exact locations of these sunken vessels are not known, but the geographic information would be available from the SHPO (USACE, 2009a).

The wreck of the *Josephine* (22HR843) is a sunken iron-hull sidewheeler listed in the NRHP in 2000. The *Josephine* is significant for the data she could possess about the shipping industry and the development of 19th century iron-hulled steamship construction and technology. It is likely that this shipwreck will be outside the project APE, once it is established (MMS, 2006; USACE, 2009a).

The entire Gulf coast area in Mississippi was designated a national heritage area in 2004. The Mississippi Gulf Coast National Heritage Area includes the six coastal counties in Mississippi and the islands in this project area. Three NRHP-listed properties are shown in the heritage area off the coast of Mississippi: Fort Massachusetts on West Ship Island, the French Warehouse site on East Ship Island, and the Round Island Lighthouse on Round Island (MDMR, 2005).

A literature search for the West Ship Island North Shore Restoration project found that shipwrecks are located in the Gulf of Mexico along the Mississippi coast, but that none of the shipwrecks within that project APE were significant and none were found to be eligible for listing in the NRHP. Officially recorded marine archaeological sites in the region also were not located in that project's APE (USACE, 2010b). Archaeological site 22HR640, dating from the Paleo-Indian period, is located in the vicinity of the remains of the historic lighthouse on West Ship Island. The condition and NRHP status of this site are unknown. Another site on East Ship Island is the Quarantine Station, which was submerged after Hurricane Katrina. The current NRHP status is unknown. No other cultural resources were identified in the West Ship Island North Shore Restoration project environmental assessment (EA) or other documents consulted regarding Ship Island (NPS, 2010b; USACE, 2009a; USACE, 2010b).

Fort Massachusetts on the northern shore of West Ship Island was built alternately by Confederate and U.S. Government forces between 1859 and 1866 as a part of a program to bolster national defense. It was listed in the NRHP in 1971. According to the 1971 NRHP nomination form, the fort has national, state, and local significance. In keeping with the style and materials of the time, it is built of brick with segmental arches. The fort is constructed in the shape of a D, with the rounded side facing the water. It is significant for its architectural integrity as well as for the events that took place around it, including the Civil War. It is an integral component of the collection of seacoast defensive structures that represent Gulf coast development from early exploration and colonization through the mid-twentieth century (Maddox 1971; NPS, 2010b; USACE 2010a).

On East Ship Island, there is an archaeological site, 22HR638, that contains both historic and prehistoric materials. Referred to as the French Warehouse site, it was listed in the NRHP in 1991 for its significance under Criterion D for the data it could provide on the history of Mississippi and the region, particularly 18th century commerce and reconstruction of past lifeways, including French exploration and Gulf coast settlement. The site is approximately 8 acres and is made up of the remains of a complex of warehouse buildings established before 1720 to serve as the primary port for the capital of New Biloxi because the harbor at Biloxi was too shallow for larger ships. The site sustained damage during Hurricane Katrina, but is still accessible (Hammersten, 1991; USACE, 2009a).

In 2012, NPS archaeologists conducted a remote sensing (magnometer) survey of Camille Cut by boat. They survey identified anomalies in the area that could require additional investigation. USACE is currently conducting additional surveys in Camille Cut to investigate anomalies identified by the NPS, surveys on the southern placement, and surveys on offshore borrow areas to identify potential cultural resource sites. The results of these additional surveys will be summarized in the Final SEIS. In addition, the higher elevation inland placement areas on East Ship Island will be surveyed for possible resources.

4.9 Visual and Aesthetic Resources

Visual and aesthetic resources in the project area consist of the Mississippi barrier islands, Mississippi Sound, and the natural areas along the coastline of Mississippi and offshore in the Gulf of Mexico. These areas are used for a variety of recreational activities, including viewing nature and wildlife.

The barrier islands include the Mississippi barrier islands within the GUIS. These include East Ship and West Ship Islands, Horn Island, Petit Bois Island, and their adjacent waters, and parts of Cat Island. The islands are listed as a national watchable wildlife area and include designated wilderness areas (Horn Island and Petit Bois Island) (NPS, 2010a).

The following description is summarized from Marsh (2010). Aesthetic resources on Petit Bois Island include sandy beaches and pond/lagoon complexes. Its Gulf beach is composed of white quartz sand up to 500 feet wide. The island provides excellent feeding, resting, and wintering habitat for numerous types of migrant and wintering waterfowl species. Horn Island contains white sand beaches and dunes, pines and live oak trees, numerous marshes, and ponds and lagoons in the interior. It supports abundant wildlife and is used by both campers and hikers. East Ship Island and West Ship Island contain beautiful beaches as well as historic resources that draw over 60,000 visitors each year. Cat Island contains a greater diversity of vegetation and wildlife than any of the islands currently within the project area. Habitats include saltwater marsh, ephemeral saltwater marsh, freshwater marsh, palmetto-slash pine forest, and live oak stands.

Several governmental entities manage natural resources along the Mississippi coastline. The MDMR manages sensitive coastal wetland habitats along the Mississippi Gulf coast as part of its Coastal Preserves Program. The State owns approximately 30,000 acres of coastal habitat. The managed sites include Davis Bayou, Grand Bay, and the Pascagoula River marshes, as well as Round Island in Mississippi Sound (MDMR, 2010e). Three wildlife refuges, Mississippi Sandhill Crane, Grand Bay, and Bon Secour, are part of the Gulf Coast Refuge Complex, which is managed by the USFWS (USFWS, 2010j). The NPS manages the resources within the Mississippi coastal portion of the GUIS (i.e., Davis Bayou Unit). Additionally, offshore oil rigs are visible in the Gulf of Mexico.

4.10 Noise

Noise is measured in sound pressure units called decibels (dB). For determination of impacts on human receptors, noise measurements are weighted to increase the contribution of noises within the normal range of human hearing and to decrease the contribution of noises outside the normal range of human hearing. Human hearing is best approximated by using an A-weighted decibel scale (dBA). The A-weighted scale takes into account the lower sensitivity of the human ear to noise with a frequency lower than 1 kilohertz. When sound pressure doubles, the dBA level increases by 3. Psychologically, most humans perceive a doubling of sound as an increase of 10 dBA (USEPA, 1974). Sound pressure decreases with distance from the source. Typically, the amount of noise from a continuous source is halved (reduced by 3 dBA) as the distance from the source doubles (USEPA, 1974). The underwater sound dB scale is different than the in-air dB scale. A 100-dB in-air sound does not represent the same intensity level as a 100-dB in-water sound. The in-water intensity level is lower than the equivalent in-air dB value (Kipple and Gabriele, 2007).

Noise sources in the project area consist primarily of natural background sounds—the ocean, coastal winds, and fauna. Anthropogenic sources include fishing/shrimp boats, pleasure craft, dredges, shipping traffic, oil/natural gas rigs, and aircraft from Keesler Air Force Base and Gulfport-Biloxi International Airport. For example, shipping traffic throughout the GIWW exceeds 232,000 vessel trips per year (USACE, 2008).

There are no sensitive human noise receptors in the open water of Mississippi Sound and in the OCS. There are only limited sensitive human noise receptors on the Mississippi barrier islands (i.e., vacation houses on Cat Island). The next nearest significant receptors are residential areas and schools along the coastline. In addition to these sensitive receptors, temporary park visitors and NPS staff within the GUIS and pleasure boaters and fishermen in Mississippi Sound occur periodically within the project area.

4.11 Air Quality

The Clean Air Act (CAA) requires USEPA to set National Ambient Air Quality Standards (NAAQS) for pollutants considered harmful to public health and the environment. NAAQS include two types of air quality standards. Primary standards protect public health, including the health of sensitive populations, such as asthmatics, children, and the elderly. Secondary standards protect public welfare, including protection against decreased visibility and damage to animals, crops, vegetation, and buildings (USEPA, 2010). USEPA has established NAAQS for six principal pollutants, which are called “criteria pollutants.” Criteria pollutants include carbon monoxide (CO), lead, nitrogen dioxide, particulate matter (PM), ozone, and sulfur dioxide (USEPA, 2010). Areas that meet the air quality standard for the criteria pollutants are designated as being "in attainment." Areas that do not meet the air quality standard for one of the criteria pollutants may be subject to the formal rule-making process and designated as being "in non-attainment" for that standard. Coastal counties in Mississippi are in attainment for all NAAQS (MDEQ, 2010c).

4.11.1 Emission Sources

Shipping traffic and vehicular land traffic contribute to mobile emission sources along coastal Mississippi. Major traffic areas are located along U.S. 90 and I-10. Ground vehicle use and shipping are mostly pass-through traffic and contribute only minimally to air pollution.

Dredging activities, commercial shipping, and operation of smaller watercraft contribute air emissions periodically in and around parts of the project area. Total emissions vary based on the duration of activities and the type of equipment used.

USEPA estimates that commercial watercraft entering, leaving, and operating in the Port of Gulfport generate 5 tons/year of total hydrocarbons (THC), 49 tons/year of CO, 322 tons/year of nitrogen oxides (NOx), 13 tons/year of PM and 81 tons/year of sulfur oxides (SOx). Waterborne activities associated with the Port of Pascagoula are estimated to generate 19 tons/year of THC, 111 tons/year of CO, 937 tons/year of NOx, 66 tons/year of PM, and 465 tons/year of SOx (USEPA, 2002).

There are no permitted sources of air emissions on the barrier islands.

Emission factors for diesel-powered dredging vessels, which would be the large vessels most frequently operating as part of the action alternatives, are shown in Table 4-9.

TABLE 4-9
Emission Factors for Diesel-Powered Dredging Vessels

Operating Mode	PM (lb/Mgal)	TOG (lb/Mgal)	NOx (lb/Mgal)	SOx (lb/Mgal)	CO (lb/Mgal)
<500 horsepower					
Full (80% Power)	17	21	275.1	125.6	58.5
Cruise (50% Power)	17	51.1	389.3	125.6	47.3
Slow (20% Power)	17	56.7	337.5	125.6	59
500–1,000 horsepower					
Full (80% Power)	17	24	300	125.6	61
Cruise (50% Power)	17	17.1	300	125.6	80.9
Slow (20% Power)	17	16.8	167.2	125.6	62.2

Note: PM = particulate matter; lb/Mgal = pounds per million gallons; TOG = total organic gases; NOx = nitrogen oxides; SOx = sulfur oxides; CO = carbon monoxide
Source: California Air Resources Board, 1999

Typical dredges are estimated to operate 14 hours a day for 190 days per year, consuming 19.14 gallons of diesel fuel per hour (California Air Resources Board, 1999). Under that alternative, approximately 50,912 gallons of fuel would be consumed and annual emissions for a 1,000-horsepower dredge would be:

- 0.86 tons PM
- 0.85–1.22 tons TOG

- 8.5–15.3 tons NOx
- 6.4 tons SOx
- 3.1–4.1 tons CO

4.12 Recreation

Coastal-based tourism and recreation account for approximately one-third of Mississippi's tourism industry. Opportunities for recreation include arts and entertainment, boating, golfing, sightseeing, picnicking, swimming, bird watching, and fishing. Dockside gaming and casinos are also a major attraction for tourists (USACE, 2009a). Table 4-10 shows the number of people who participated in coastal-based recreation activities based on the most recent national survey on recreation and the environment in 2001. Visiting the area beaches and photographing scenery attracted the highest number of participants in 2001.

TABLE 4-10
Participation in Coastal Recreation in Mississippi

Activities	Participants (Millions)
Visit Beaches	1,042,000
Swimming	563,000
Snorkeling	25,000
SCUBA Diving	4,000
Wind Surfing	8,000
Fishing	312,000
Motorboating	228,000
Sailing	47,000
Personal Watercraft	70,000
Canoeing	10,000
Kayaking	5,000
Water-Skiing	39,000
Bird watching	317,000
Viewing Other Wildlife	235,000
Photographing Scenery	1,324,000
Hunting Waterfowl	6,000
Total	**4,235,000**

Source: Leeworthy and Wiley, 2001

4.12.1 Gulf Islands National Seashore

The barrier islands are part of GUIS and are owned and managed by the NPS. Recreational uses on the islands include general recreation, such as boating, sightseeing, picnicking, swimming, and fishing from banks and boats. Additionally, the western portion of Ship Island, known as West Ship Island, is home to a nationally registered historic site, Fort Massachusetts, and East Ship Island is home to a second one, the French Warehouse. Fort Massachusetts is open for free public tours.

Horn, Petit Bois, Sand, and East Ship Islands are open year-round to private boaters. West Ship Island is open to private boaters from sunrise to sunset. The 2 miles of the western tip and the southern tip of Cat Island are within the GUIS boundaries and are open to private boaters. The islands are not accessible by automobile. West Ship Island is also accessible by a privately owned ferry company under contract with NPS, Ship Island Excursions. Passengers are ferried from Gulfport 12 miles (19 km) out to the island for a fee (Ship Island Excursions, 2010). Prior to 2005 (2000–2005), public visitation to East Ship and West Ship Islands ranged from 62,000–66,000 visitors per year. The 2005 Atlantic hurricane season did considerable damage to the public infrastructure of the islands and several of the historic forts, and caused a severe decline in public visitation. For 2006 and 2007, visitation was approximately 20,000 and 37,000, respectively. By 2009, visitation had not returned to pre-Katrina levels, approximately 43,000 (NPS, 2010c).

4.12.2 Gaming

Casino gaming is a major tourist attraction in the project area, and many casinos were destroyed or damaged as a result of Hurricane Katrina. Gross gaming revenues went from over $100 million per month before Hurricane Katrina to $0 after the storm. The industry rebuilt during 2006 and in 2007, and gaming revenues have rebounded to near pre-Katrina levels. Revenues for 2012, the most recent year for which data are available, were $1,094,789,448, which is approximately $91 million per month (Mississippi State Tax Commission, 2013).

4.13 Socioeconomic Resources

The socioeconomic Region of Influence (ROI) for the restoration alternatives is defined as the geographic area within which the restoration alternatives are likely to have a direct or indirect effect on socioeconomic resources. The ROI for socioeconomic resources that could be affected by the barrier island restoration was determined by the physical location of the restoration alternatives as well as the areas that are likely to experience social and economic impacts from future coastal storm events. The barrier islands, Mississippi Sound, and the coastal regions of Mississippi shown in Figure 1-1 comprise the geographic area of the ROI. This includes areas within Hancock, Harrison, and Jackson Counties, Mississippi. The major cities include (from west to east) Waveland, Bay St. Louis, Pass Christian, Long Beach, Gulfport, Biloxi, Ocean Springs, Gautier, Moss Point, and Pascagoula. The socioeconomic resources within the ROI are summarized below. Additional details are available in the economics appendix (Appendix B) of the MsCIP PEIS (USACE, 2009a).

The State of Mississippi was profoundly impacted by Hurricane Katrina. In 2005, insured losses from hurricanes and other catastrophes were greater than in any other year in U.S. history. NOAA's National Hurricane Center estimates that $85 billion of total damage to all affected areas resulted from Hurricanes Katrina and Rita alone. More than 7 years later, the region continues to struggle to recover as both a place to live and as a workable economy.

This section includes existing conditions information on demographics, Environmental Justice (EJ), economics, land, water, transportation, utilities, public safety, and navigation and ports within the ROI.

4.13.1 Demographics

This section summarizes the demographic trends within the ROI. According to the U.S. Census, the ROI experienced small population changes from 2000–2010. Hancock, Harrison, and Jackson Counties experienced population changes of +1.0 percent, -2.5 percent, and +5.4 percent, respectively. The State of Mississippi experienced a population increase of 3.9 percent and the United States an increase of 8.3 percent over the same time period (U.S. Census Bureau, 2000; U.S. Census Bureau, 2010).

Hurricane Katrina had a significant impact on the population along the Gulf coast. Because significant portions of some cities were destroyed, other cities which remained unscathed from the hurricane such as Baton Rouge became home to new populations of people seeking to start over as their homes and businesses were destroyed. Others who were temporarily displaced by the hurricane returned and began rebuilding homes. In some areas, populations increased or decreased as these populations shifted. For example, Hancock County experienced a 24.0 percent loss of population after Katrina. Population estimates before and the year after Hurricane Katrina for the counties within the ROI and the State of Mississippi are included in Table 4-11.

TABLE 4-11
Population Estimates Before and After Hurricane Katrina

	Percent Population Change between 1990 and 2000	2000[a] Population	Estimated June/July 2005 Population		Estimated 2006, Population		Percent Change
			(Pre-Hurricane Katrina)[b]	Population Change 2000–2005	(Post-Hurricane Katrina)[c]	Post-Katrina Population Change	
Hancock County	35.3%	42,967	46,240	3,273	35,129	-11,111	-24.0%
Harrison County	14.7%	189,601	186,530	-3,071	155,817	-30,713	-16.5%
Jackson County	14.0%	131,420	134,249	2,829	126,311	-7,938	-5.9%
Mississippi	10.5%	2,844,658	2,921,088	76,430	2,910,540	-10,548	-0.36%
United States	13.1%	281,421,906	296,410,404	14,988,498	299,398,484	2,988,080	1.01%

Sources:
[a] U.S. Census Bureau. 2000.
[b] City-data.com. 2010.
[c] U.S. Census Bureau. 2006.

4.13.2 Economics

Important socioeconomic assets within the Gulf of Mexico and along the Mississippi coast include commercial fishing and seafood processing, tourism, energy production, shipping and associated maritime services, and NASA's Stennis Space Center. The Gulf ecosystem and its natural resources produced 30 percent of the nation's gross domestic product in 2009. The region provides more than 33 percent of the nation's seafood and, of the top 20 ports by tonnage in the United States in 2009, 13 were in the region (Gulf Coast Ecosystem Restoration Task Force, 2011).

The Gulf region contains one-fourth of the nation's seafood processing and wholesale establishments and provides jobs and recreational activities such as marine sport-fishing (Adams et al., 2004; Mississippi State University [MSU], 2004). NOAA Fisheries reported that the Gulf States produce approximately 1.7 billion pounds (approximately 772 million kg) of fish and shellfish valued at more than $705 million annually (NOAA Fisheries, 2004b). Hundreds of commercial and sport-fishing boats operate out of Mississippi (Gulf Coast Ecosystem Restoration Task Force, 2011).

The Gulf of Mexico accounts for 90 percent of the U.S. offshore oil and natural gas production and about 23 percent of the resulting U.S. gasoline production. The infrastructure for oil and gas production in the Gulf area is concentrated in coastal Louisiana and east Texas. About 55,000 workers are employed in the Gulf petroleum-related offshore industry (USACE, 2009c). Shipping and maritime services are an important part of the Gulf economy. For example, within Mississippi, the Mississippi State Port at Gulfport generates more than 2,000 jobs for Mississippi residents, with that number expected to increase. The largest military shipbuilder in the United States is located in Pascagoula. As the largest private employer in the state, it provides 11,000 jobs for residents of the northern Gulf region (Gulf Coast Ecosystem Restoration Task Force, 2011). Coastal tourism and recreation in the three Mississippi counties that border the Gulf Coast account for about $1.6 billion in visitor expenditures, 32 percent of state travel and tourism tax revenues, and 24,000 direct jobs (Gulf Coast Ecosystem Restoration Task Force, 2011). Dockside gaming development and casinos have displaced other waterfront-dependent industries in some locations. Demand for coastal housing also increased, with new residents employed in the gaming industry. Rezoning and dockside casino accommodations have also resulted in a shortage of mooring facilities for small commercial and recreational craft, and waiting lists have developed for dock spaces (MSU, 2004).

NASA's Stennis Space Center on the Mississippi coast supports more than 30 federal, state, academic, and private organizations and numerous technology-based companies and employs approximately 2,000 people (Gulf Coast Ecosystem Restoration Task Force, 2011).

In addition, economic conditions and trends in the Gulf coast region are closely associated with land and water transportation (Mississippi Department of Transportation [MDOT], 2004). The area has transitioned in recent years from an industrial/manufacturing economy to a service-based economy. The service sector growth has resulted in new transportation demands and expectations (MDOT, 2004).

4.13.2.1 Employment

The total employment in Harrison (88,500), Hancock (14,380), and Jackson (53,060) Counties in 2009 made up approximately 13 percent of the total state employment (1,205,500). The number of residents employed in the major sectors of the labor market in 2009 varied by county. Government, leisure and hospitality, and retail trade industries employed the highest number of workers in Harrison and Hancock Counties, whereas manufacturing, government, and retail industries were the dominant employers in Jackson County.

Immediately following Hurricane Katrina, unemployment rates were close to 20 percent in the three coastal Mississippi counties. However, as these counties rebuilt and populations shifted, unemployment rates decreased. The unemployment rate for Jackson County decreased from 14.4 percent in January 2006 to 6.9 percent in November of the same year. Significant unemployment rate decreases occurred over that period: 18.5 to 8.3 percent in Harrison County and 16.8 to 5.3 percent in and Hancock County (Mississippi Governor's Office of Recovery and Renewal, 2007; Mississippi Gulf Coast, 2006).

Unemployment increased again in 2009 following a national trend, with rates for Hancock, Harrison, and Jackson Counties at 8.0 percent, 7.6 percent, and 8.3 percent, respectively. These rates were lower than the rates for the U.S. (9.3 percent) and State of Mississippi (9.6 percent) (U.S. Bureau of Labor Statistics, 2009; Mississippi Department of Employment Security [MDES], 2010).

4.13.2.2 Housing

Hurricane Katrina had a devastating impact on the housing stocks of south Mississippi. The total number of housing units destroyed or damaged by Hurricane Katrina in the Mississippi Gulf coast area was 234,284 (USACE, 2010b). At the highest point, there were over approximately 40,000 Federal Emergency Management Agency (FEMA) trailers and mobile homes in the three coastal counties of Mississippi. As of August 2010, only 79 of the more than 40,000 FEMA trailers that were once located in the three coastal counties remained in service (Gulf Coast Business Council Research Foundation, 2010). More than 90 percent of homes in Harrison and Jackson Counties did not have flood insurance prior to Hurricane Katrina. Most of the housing (62 percent) in the three coastal Mississippi counties was built before 1980 (Bernstein et al., 2006). As a result, the cost to repair storm damage exceeded the insured value of the property. Programs have been implemented in Mississippi to help provide affordable housing to those who were affected, while other states also have helped accommodate displaced Mississippi residents.

New housing starts in the three coastal counties increased after Hurricane Katrina (2006) but slowed again in 2008 following the financial crisis and decline in the nationwide housing market. Harrison County had the highest number of building permits for single-family new construction since Hurricane Katrina compared to nearby Hancock and Jackson Counties.

4.13.3 Commercial and Recreational Fishing

The Gulf of Mexico fisheries are some of the most productive in the world. The Gulf produces approximately 40 percent of the total U.S. fisheries landings (Lynch et al., 2003) and about 28–30 percent of the total fishery products of the United States. Within the Gulf of Mexico, the region known as the Fertile Fisheries Crescent has been called the core of the Gulf fishing industry. The Fertile Fisheries Crescent extends across three areas: the West Florida Shelf, the Mississippi-Alabama Shelf, and the Louisiana-Texas Shelf. Mississippi Sound is located within the very center of the Fertile Fisheries Crescent (USACE, 2009a).

In 2009, the commercial fish and shellfish harvest from the five U.S. Gulf States was estimated to be nearly 1.43 billion pounds. In the same year, commercial catches in the Gulf were valued at over $629 million. The State of Mississippi accounted for over 230 million pounds of commercial fisheries landings in 2009, exceeded only by Louisiana among the Gulf States (NOAA Fisheries, 2010b). Of the Mississippi commercial fisheries landings in 2009, approximately 217.4 million pounds were attributed to the Pascagoula-Moss Point area and 12.9 million pounds were attributed to the Gulfport-Biloxi area (NOAA Fisheries, 2010c). The majority of these commercial fisheries landings in Mississippi for 2009 occurred from May to September (NOAA Fisheries, 2010d). Table 4-12 summarizes the quantity and value of the commercial catch for Pascagoula-Moss Point, Gulfport-Biloxi, the State of Mississippi, and the four other Gulf States during 2009.

4.13.3.1 Fish

The Gulf of Mexico leads the U.S. in the level of recreational fishing. Lynch et al. (2003) reported 264,718 marine recreational anglers comprising over 1 million angling trips in 2002 in Mississippi. Gulf States Marine Fisheries Commission (GSMFC) reported 4,045 marine licenses sold in 2009 generating revenues of $373,896 for the state (GSMFC, 2010). This number is a significant decrease from the 69,458 licenses (worth $961,070) issued in 2008.

NOAA Fisheries tracks the economic impact of commercial and recreational fishing in the Gulf of Mexico. The major fisheries species that are regulated by NOAA Fisheries and GMFMC for the Mississippi Gulf coast are listed in Table 4-13 along with the 2009 landing statistics.

Pascagoula-Moss Point is the center of Mississippi’s Gulf menhaden fisheries industry, which accounts for the largest total landings of seafood in the state (NOAA Fisheries, 2010c). The menhaden are used in reduction fisheries to produce fish meal, fish oil, and condensed fish soluble, which are components in animal feeds, paints, plastics, and resins.

TABLE 4-12
2009 Value of Finfish and Shellfish in the Gulf States, Mississippi, Pascagoula-Moss Point, and Gulfport-Biloxi

	Catch (pounds)	Value ($)
Finfish		
Mississippi	217,461,279	18,667,208
Alabama	4,456,317	3,656,016
Florida (west coast)	37,921,822	49,163,740
Louisiana	806,493,773	62,444,748
Texas	4,134,484	7,487,760
Shellfish		
Mississippi	12,823,138	19,331,265
Alabama	25,236,769	36,873,742
Florida (west coast)	27,391,980	66,926,894
Louisiana	198,650,911	221,980,686
Texas	95,362,580	142,744,171
Total Commercial Fisheries		
Gulf of Mexico	1,429,933,053	629,276,230
State of Mississippi	230,284,417	37,998,473
Port of Pascagoula-Moss Point	217,400,000	18,600,000
Port of Gulfport-Biloxi	12,900,000	19,300,000

Sources: NOAA Fisheries, 2010b; NOAA Fisheries, 2010c.

TABLE 4-13
2009 Commercial Fish Landing Statistics for Mississippi

Common Name	Species Name	Landing (pounds	Value ($)
Finfish			
Croaker, Atlantic	*Micropogonias undulatus*	105	53
Drum, Black	*Pogonias cromis*	9,608	2,926
Drum, Red	*Sciaenops ocellatus*	32,027	50,432
Finfishes (general)	*UNCLASSIFIED*	485,555	237,661
Flatfish (Flounders)	*Bothidae* sp,	24,695	57,815
King Whiting	*Menticirrhus* sp.	5,636	4,755
Menhaden	*Brevoortia patronus*	216,709,145	17,986,861
Mullet, Striped	*Mugil cephalus*	62,330	29,993
Seatrout, Sand	*Cynoscion arenarius*	8,249	6,604
Seatrout, Spotted	*Cynoscion nebulosus*	52,615	120,614
Sheepshead	*Archosargus probatocephalus*	11,675	6,714
Snapper, Gray	*Lutjanus griseus*	1,440	3,553
Snapper, Red	*Lutjanus campechanus*	57,264	157,560
Tripletail	*Lobotes surinamensis*	935	1,667

Source: NOAA Fisheries, 2010a

4.13.3.2 Shellfish

The common commercial and recreational shellfish of the Mississippi coastal region are listed in Table 4-14. MDMR regulates shellfish in the generic categories of crab, oyster, and shrimp fisheries through recreational and commercial licenses and establishment of seasons for those species (MDMR, 2010f; MDMR, 2010g).

TABLE 4-14
2009 Commercial Shellfish Landing Statistics for Mississippi

Common Name	Species Name	Landing (lb)	Value ($)
Crab, Blue	*Callinectes sapidus*	545,328	572,852
Oyster, Eastern	*Crassostrea virginica*	2,191,724	6,100,264
Shellfish (general)	*UNCLASSIFIED*	2,445	4,003
Shrimp, Brown	*Penaeus aztecus*	6,347,459	6,847,481
Shrimp, Pink	*Penaeus duorarum*	480	192
Shrimp, White	*Penaeus setiferus*	3,735,702	5,806,473

Source: NOAA Fisheries, 2010a

Shrimp

Brown, white, and pink shrimp are the three major types of shrimp harvested on the Mississippi coast. Approximately 63 percent of the harvest was brown shrimp in 2009 (NOAA Fisheries, 2010b). Mississippi's annual commercial shrimp landings for 2009 were 10.1 million pounds. The dockside value of this harvest, according to NOAA Fisheries statistics for 2009, was $12.7 million. In recent years, a rise in the amount of foreign shrimp being imported into the U.S. has caused the dockside price to decrease (MDMR, 2010g).

The Commission on Marine Resources establishes season opening and closing dates for shrimp fisheries and regulates the size and number of trawls pulled by boats. The MDMR collects shrimp samples to aid in determining the time to open shrimp season.

Crabs

The blue crab is the most important commercial crab species in the Gulf of Mexico. In Mississippi, 545,328 pounds of blue crab landings valued at $572,852 were reported in 2009 (NOAA Fisheries, 2010b).

Oysters

The Eastern oyster is one of the more valuable resources of the Mississippi Gulf coast. More than 2 million pounds of oysters worth over $6 million were collected in 2009 (NOAA Fisheries, 2010b).

Oyster reefs are typically located in shallow waters that rapidly change in temperature and salinity. The MDMR manages 17 natural oyster reefs. Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs (MDMR, 2010h).

4.13.3.3 Other

Other commercial species of importance in the Gulf include sponges, squids, conchs, sand dollars, and sea biscuits. Commercial sponge harvesting is generally limited to the eastern Gulf along the Florida coast. The squid industry in the Gulf is associated with the seafood industry and typically squid collected for consumption are by-catch from fishing trawls. The conchs, sand dollars, and sea biscuits taken along the Gulf are generally used for souvenirs in the tourism industry.

4.13.4 Land and Water Use

Hurricane Katrina damaged tens of thousands of acres in coastal Mississippi as well as the barrier islands. Intense winds and salt spray affected thousands of acres of standing trees, wetlands, and other vegetation, and how much will survive remains unknown.

The Mississippi Forestry Commission estimated that 60 percent of the coastal forests have been lost.

Wind, rain, and storm surge destroyed tens of thousands of homes, thousands of small businesses, and dozens of schools and public buildings. The highways, arterial roadways, ports, railroads, and water and sewer systems suffered varying degrees of damage, in some cases complete destruction.

Destroyed and damaged infrastructure, businesses, and homes have been and are being reconstructed through federally funded disaster relief efforts, loan programs, and small business loan programs. State and federal environmental restoration and hurricane protection programs are in the planning stages, and potential protection and redevelopment projects are being evaluated and implemented.

4.13.4.1 Territorial Water Boundaries

The project area includes both State and Federal territorial waters in Mississippi Sound and along the OCS. State territorial waters and therefore state jurisdiction extends for 3 nautical miles from the baseline along either the coast or the barrier islands. Federal territorial waters extend to 12 nautical miles from the baseline (NOAA, 2013).

4.13.4.2 Gulf Islands National Seashore

The project area includes borrow and placement locations within GUIS, Mississippi unit. GUIS's purpose is to preserve, protect, and interpret its Gulf Coast barrier island and bayou ecosystem and its system of historic coastal defense fortifications, while providing for public use and enjoyment. NPS resources are managed primarily through the NPS's *Management Policies* (2006). Chapter 3 of the *Management Policies* establishes governing principals for land protection and management, and Chapter 9 includes specific restrictions for borrow pits and spoil areas. In accordance with the NPS Management Policies, dredging from borrow pits on NPS lands (such as DA-10/Sand Island) can be undertaken only if dredging will not impair park resources or values, is economically, environmentally, and ecologically reasonable, and provides the only reasonable source of borrow material. These policies must be considered during evaluation of the environmental effects (Section 5) and selection of the TSP.

NPS's vision for management of the Mississippi barrier islands includes the preservation of natural biological and geological marine and terrestrial conditions and processes, and the preservation of cultural resources, consistent with peer-reviewed and documented scientific study (USACE, 2009a). Horn and Petit Bois Islands are designated as a wilderness area, the Gulf Islands Wilderness, and receive an even higher level of protection. In wilderness areas, the NPS vision and management focus on providing park visitors with an undisturbed environment, a pristine and unencumbered viewshed, an atmosphere of solitude, an opportunity for primitive, unconfined recreation, and negligible evidence of resource impairment. NPS implements this vision by controlling nonconforming uses, preventing unnecessary or undue reduction of wilderness values, and applying the "minimum requirement" concept of the 1964 Wilderness Act to all proposed projects involving these islands. In addition, only recreational fishing is allowed within the GUIS boundaries.

Based on federal statutes such as the NPS Organic Act and the GUIS' enabling legislation, NPS management policies, and management plans, NPS is mandated to preserve and protect the natural conditions and processes affecting the barrier islands, and to preserve the significant cultural resources existing on the islands. In addition, GUIS's enabling statute directs that beach erosion control measures and spoil deposition activities in the park undertaken by USACE must be carried out in a manner that is acceptable to NPS and consistent with the park's purposes (16 U.S.C. § 459h-5). NPS must also fully and properly utilize and integrate the results of scientific study for park management decisions (16 U.S.C. § 5936) (USACE, 2009a).

4.13.4.3 Air and Rail Transportation

Although there are some smaller airports throughout coastal Mississippi, the Gulfport-Biloxi International Airport is the only passenger airport accepting major commercial airlines. Stennis International Airport, located 8 miles north of Bay St. Louis, is owned and operated by the Hancock County Development Commission. The Mississippi Gulf Coast is served by three railroads: the CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, and Port Bienville Shortline Railroad. CSX is a Class I railroad serving the developed portion of the Mississippi coastal area. Its main lines traverse most of the region's municipalities. The CSX track has an east-west orientation and serves as a major linkage between the deepwater ports in New Orleans and Mobile through connection lines from each port. This line is also a major connector across the country between Jacksonville, Florida and Los Angeles, California The main line of the KCS Railroad, also a Class I railroad, has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest Counties to Hattiesburg, Mississippi. The Port Bienville Shortline Railroad is a Class III railroad with 9 miles of track owned and operated by the Hancock County Port and Harbor Commission. It serves the Port Bienville Industrial Park and connects with the CSX line southwest of Waveland (USACE, 2010b).

4.13.5 Utilities

Utilities include water supply, wastewater, stormwater, solid waste, hazardous waste, telecommunications, and energy systems. The geographical region evaluated for utilities encompasses the coastal regions of Hancock, Harrison, and Jackson Counties. Utility services are summarized in Table 4-15 (USACE, 2009a). In addition, the NPS provides limited electrical, water, and wastewater utilities at Horn and West Ship Islands.

TABLE 4-15
Utility Services for Hancock, Harrison, and Jackson Counties, Mississippi

County Name	Electricity	Natural Gas	Water and/or Sewer	Telephone
Hancock	Coast Electric Power Association and Mississippi Power Company	Bay St. Louis Utilities Department and Waveland Gas and Water Department	Bay St. Louis Utilities Department, Diamondhead Water and Sewer, Kiln Water District, and Waveland Gas and Water Department	AT&T South
Harrison	Coast Electric Power Association and Mississippi Power Company	Center Point Energy	Eco Resources, Westwick Utilities, City of D'Iberville Water and Sewer Department, Long Beach Water Department, and Pass Christian Utilities Department	AT&T South
Jackson	Mississippi Power Company and the Singing River Electric Power Association	Center Point Energy and Pascagoula Utilities Department	Ocean Springs Water and Sewage Department, Coast Water Works, Magnolia Utilities, Gulf Park Water, Gautier Utility District, Pascagoula Utilities Department	AT&T South

Source: USACE, 2009a

4.13.5.1 Water Supply

Approximately 88 community water systems provide potable water to the Mississippi Gulf coast. The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and is delivered by a system of wells, water distribution piping, and water storage tanks. All of these systems rely on groundwater as their sole source of supply for drinking water, although in Jackson County surface water is used for industrial end use (USACE, 2009a).

4.13.5.2 Wastewater

In coastal Mississippi, 49.5 percent of Hancock County, 18.9 percent of Harrison County, and 27.0 percent of Jackson County do not have access to a public wastewater system. Those who are not connected to a public wastewater system use onsite treatment, which consists of either package plants or septic tanks/drain fields. Package plants are small, self-contained wastewater treatment facilities built to serve a developed area, such as a subdivision (USACE, 2009a).

The wastewater treatment facilities in the ROI treat more than 45 million gallons of wastewater each day. Hancock County facilities treat approximately 3 million gallons per day (mgd), Harrison County facilities treat 29.3 mgd, and Jackson County facilities treat 12.0 mgd (USACE, 2009a).

4.13.5.3 Stormwater

MDEQ has been delegated responsibility for the NPDES stormwater program for local governments. Hancock, Harrison, and Jackson Counties are all Phase II municipal separate storm sewer system (MS4) governments, as are Bay St. Louis, Biloxi, D'Iberville, Gautier, Gulfport, Long Beach, Moss Point, Ocean Springs, Pascagoula, Pass Christian, and

Waveland. The NPDES Phase II stormwater program requires local governments to develop stormwater programs that include six minimum control measures:

- Public education and outreach
- Public involvement and participation
- Illicit discharge detection and elimination
- Construction site runoff control
- Post-construction runoff control for new development and redevelopment
- Pollution prevention and good housekeeping

The City of Gulfport has developed a storm drainage master plan that addresses the need to eliminate stormwater-related flooding in the Gulfport and Orange Grove areas. Jackson County and each municipality within the county have adopted a stormwater plan that addresses the capabilities and requirements of the various stormwater systems.

4.13.5.4 Solid Waste Disposal and Collection System

There is one permitted municipal solid waste landfill in the ROI, and there are seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, located in Pass Christian, receives approximately 90 percent of the total solid waste stream produced in the three coastal Mississippi counties (USACE, 2009a).

4.13.6 Oil and Gas Utilities

Oil and gas leases and active extraction operations are located off the Mississippi and Alabama coastlines, seaward of the barrier islands. Active lease areas and oil and gas infrastructure are located seaward of Petit Bois Island near the Petit Bois borrow areas. Pipelines connecting this infrastructure to the coast extend through portions of the project area. Pipelines pass between Horn and Petit Bois Islands to Pascagoula, between Petit Bois and Dauphin Islands to Pascagoula, and between Petit Bois and Dauphin Islands to Mobile. Pipelines also connect directly to Dauphin Island (BOEM, 2010, 2013). A high-pressure gas pipeline, the Gulfstream, passes through the proposed Petit Bois Alabama borrow area. Two pipelines pass between the Petit Bois Mississippi and Petit Bois Alabama borrow area and to the West of the Petit Bois OCS borrow area (see Figure 3-9).

4.13.6.1 Deepwater Horizon

The 2010 Deepwater Horizon oil spill could potentially adversely impact USACE water resources projects and studies within the Mississippi coastal area. The USACE continues to monitor and closely coordinate with other federal and state resource agencies and local sponsors in determining how best to address any potential problems associated with the oil spill that may adversely impact USACE water resources development projects/studies. This could include revisions to proposed actions as well as the generation of supplemental environmental analysis and documentation for specific projects/studies as warranted by changing conditions. For the proposed Ship and Cat Island restoration program, USACE will coordinate with the USCG to ensure resources are available should any residual oil (tar bars) be deposited during the placement process.

4.13.7 Public Safety

Public safety resources are provided by federal, state, and local entities. Federal entities include NPS and the USCG. The NPS has ranger stations on Horn and West Ship Islands that are operated as required. The USCG has a station in Gulfport. The Gulfport station is equipped with two 41-foot utility boats, one 25-foot RB-S boat, and two 24-foot SPC-SW boats. Station Gulfport is host to three other commands, including two 87-foot patrol boats, USCG Cutters RAZORBILL and POMPANO, and Aids to Navigation Team Gulfport. There are 41 active duty members attached to the station, at times augmented by more than 60 Coast Guard Auxiliary members and 9 reservists (USCG, 2010).

The Mississippi Emergency Management Agency (MSEMA) coordinates emergency preparation, response, recovery, and mitigation activities for the State of Mississippi. MSEMA has a representative assigned to each coastal county to coordinate emergency management programs, including hurricane planning and response activities (MSEMA, 2012). Hurricane evacuation routes are designated and maintained by the MDOT and published in the Mississippi Hurricane Evacuation Guide.

Fire protection, emergency, and law enforcement services are coordinated locally by county and municipality in Hancock, Harrison, and Jackson Counties.

4.13.8 Coastal Infrastructure/Ports

The Mississippi Gulf Coast has two deep draft harbors: Gulfport and Pascagoula. These ports are served by USACE-maintained navigation channels (Gulfport and Pascagoula) connecting them to the Gulf of Mexico, as well as many other shallow draft channels, such as those in Pass Christian and Biloxi. The GIWW also crosses Mississippi Sound from east to west. The GIWW is a channel authorized to 12 feet deep and 150 feet wide.

The Port of Pascagoula is a major port in Mississippi, supporting national and international shipping commerce. The Port of Pascagoula is operated by the Jackson County Port Authority and includes public and private cargo facilities in two harbors (the Pascagoula River Harbor and Bayou Casotte Harbor), nine deepwater berths, and one barge berth. The Port’s two harbors are a combination of public and private terminals moving in excess of 35 million tons of cargo through the channels annually (Port of Pascagoula, 2010). The Pascagoula River Harbor has five of the deepwater berths, covered storage, a cold storage/freezer area, and land available for open storage. Bayou Casotte Harbor has four of the deepwater berths, covered storage, paved open storage, and unpaved open storage. The Port is public, though most facilities are operated through leases, operating agreements, or space assignment agreements with private operators or users (USACE, 2010b).

Access to the Port of Pascagoula is provided by the Pascagoula Harbor Federal Navigation project (the USACE-maintained Pascagoula Navigation Channel). The project is comprised of a number of segments: the entrance channel from the Gulf into Mississippi Sound, the Lower Sound segment which runs northward to mid-Sound where the project ‘Y’s, the Upper Sound segment to the west, which leads into the Pascagoula River segment, and the Bayou Casotte segment to the east. The Pascagoula Entrance Channel and lower Sound segments are authorized to 44 feet deep and 450 feet wide. The Upper Sound segment, which leads to the Port, is currently 350 feet wide and is authorized to a depth of 38 feet. The Bayou Casotte segment is authorized to 42 feet deep and varies in width from 225–350 feet (USACE, 2010b). To maintain the Pascagoula Navigation Channel, the USACE conducts maintenance dredging on a regular basis. Material dredged from the entrance channel is currently placed within DA-10, including areas adjacent to Sand Island. Without this dredging, sand that moves from east to west in the littoral sand transport system, and would naturally be deposited on the islands further west (Horn Island and East and West Ship Islands), accumulates in the Pascagoula Navigation Channel.

The Port of Gulfport, located directly on Mississippi Sound, encompasses approximately 204 acres, has nearly 6,000 feet of berthing space, and averages over 2 million tons of cargo a year. Water depths at the Port's 10 berths range from 32–36 feet, and berth lengths range from 525–750 feet. All are designed as multi-use, multi-purpose berths (Mississippi State Port Authority at Gulfport [MSPA], 2010). Port facilities include multi-purpose Pier 7, a rail-served heavy lift pier that was completed in January 2003 (USACE, 2009c).

Access to the Port of Gulfport is provided by the Gulfport Harbor Federal Navigation project (the USACE-maintained Gulfport Navigation Channel), which extends northward from vessel anchorage just south of East Ship Island and West Ship Island. The Entrance Channel is authorized to a depth of 38 feet, while the Sound Channel (which leads to the Port) is currently 350 feet wide and is authorized to a depth of 36 feet. The Port's north harbor is maintained to a depth of 32 feet, while the south harbor and turning basin, which are approximately 1,320 feet wide, are maintained to a depth of 36 feet (USACE, 2010b). The USACE conducts maintenance dredging on the entrance channel. Dredged material is deposited in a thin layer immediately adjacent to the channel.

4.14 Environmental Justice and Protection of Children

4.14.1 Environmental Justice

Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that "each Federal agency shall make achieving environmental justice part of its mission by identifying, and addressing as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations." Consideration of EJ through the NEPA process is accomplished through analyzing environmental effects on the natural or physical environment and interrelated effects, including human health, economic, and social effects; recommending mitigation measures whenever feasible; and providing opportunities for effective community participation in the process (CEQ, 2007).

4.14.1.1 Race and Ethnicity

The ROI for EJ includes the population centers within each county of the project area. Table 4-16 summarizes the 2010 population and racial make-up of these cities, the State of Mississippi, and the U.S. for comparison.

TABLE 4-16
Race and Ethnicity Data for the ROI

	White	Black	Hispanic[a]	Asian	American Indian	Other	Multiple Races
U.S.	72.4%	12.6%	16.3%	4.8%	0.9%	6.2%	2.9%
Mississippi	59.1%	37.0%	2.7%	0.9%	0.5%	1.3%	1.1%
Hancock County	88.4%	7.1%	3.3%	1.0%	0.5%	0.3%	2.1%
Harrison County	69.7%	22.1%	5.3%	2.8%	0.5%	0.9%	2.7%
Jackson County	72.1%	21.5%	4.6%	2.2%	0.4%	0.7%	1.9%

Source: U.S. Census Bureau, 2010
[a] Hispanic: The 2000 Census included a category for Hispanic or Latino. This category is for individuals who classify themselves in one of the specific Hispanic or Latino categories such as "Mexican," Puerto Rican," or "Cuban," as well as those who indicate that they are "other Spanish, Hispanic, or Latino." Origin can be viewed as the heritage, nationality group, lineage, or country of birth of the person or the person's parents or ancestors before arrival in the United States. People who identify their origin as Spanish, Hispanic, or Latino may be of any race.

4.14.1.2 Income and Poverty

Median household income and poverty levels for the U.S., Mississippi, and each county in the ROI, for 2010 are shown in Table 4-17. The state had a lower median income than that of the U.S. Each of the three counties in Mississippi had a higher median household income and a lower poverty rate than those of the state of Mississippi in 2010.

TABLE 4-17
2010 Median Household Income and Poverty Rate for the ROI

	Median Income	Poverty Rate
U.S.	$51,914	13.8%
Mississippi	$37,881	21.2%
Hancock County	$45,956	15.9 %
Harrison County	$44,846	16.7%
Jackson County	$50,203	14.6%

Source: U.S. Census Bureau, 2010

Mississippi has the highest percentage of low-income workers in the U.S., with more than 42 percent of all working families considered low income. More than a third of all jobs pay below-poverty wages.

The U.S. Census Bureau bases the poverty status of families and individuals on 48 threshold variables, including income, family size, number of family members under the age of 18 and over the age of 65, and amount spent on food. Table 4-18 lists the percentage of individuals under 18 and over 65 who were below the poverty level in each city and county in 2010.

TABLE 4-18
2010 Poverty Levels by Age Group for Cities and Counties Within the ROI

	Number of Individuals Below Poverty Level	Percentage Under 18 years	Percentage 65 years and over
U.S.	40,917,513	34.2%	8.7%
Mississippi	604,272	37.3%	8.7%
Hancock County	6,785	39.6%	6.1%
Harrison County	30,095	37.6%	6.5%
Jackson County	20,097	36.6%	9.4%

Source: U.S. Census Bureau, 2010

4.14.2 Protection of Children

On April 23, 1997, President Clinton issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This Executive Order directs each Federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks that are attributable to products or substances that the child is likely to come in contact with or ingest, such as air, food, water (drinking or recreation), soil, and manufactured products.

To the extent permitted by law, and appropriate and consistent with each agency's mission, each Federal agency shall make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children and shall ensure that the agency's policies, programs, activities, and standards address disproportionate health risks to children that result from environmental health risks or safety risks.

The number of children 17 years and younger for the major cities and counties of the ROI are shown in Table 4-19. The percentage of children in Hancock, Harrison, and Jackson Counties is lower than in the state of Mississippi.

TABLE 4-19
Children 17 Years and Younger in Project Area

	Male	Female	Subtotal	Total Population	Percent Children
U.S.	37,945,136	36,236,331	74,181,467	303,965,272	24.4%
Mississippi	385,763	369,792	755,555	2,941,991	25.7%
Hancock County	5,389	5,109	10,498	43,929	23.9%
Harrison County	23,373	22,480	45,853	187,105	24.5%
Jackson County	18,127	17,473	35,600	139,668	25.5%

Source: U.S. Census Bureau, 2010

5. Environmental Effects

5.1 Introduction

This section describes the environmental effects of alternative actions for restoration of the barrier islands. Performing an evaluation of environmental consequences for proposed Federal actions is a requirement of federal law (40 C.F.R. §§ 1500-1508). An impact analysis must be compared to a significance threshold to determine whether a potential consequence of an alternative is considered a significant impact. If the impact is significant, it may be mitigable (i.e., measures are available to reduce the level of impact, so it is no longer significant) or unmitigable. The discussion includes potential impacts to biological, physical, and chemical conditions, fishing and recreation, and socioeconomic conditions in the project area.

The following evaluation of environmental effects addresses the No-Action Alternative (Section 3.4.1), the TSP (Section 3.4.2), and Other Alternatives Considered (Section 3.4.3). The four main components of the TSP include: (1) Ship Island Restoration (the closure of Camille Cut and placement of sand on East Ship Island), (2) Borrow Site Option 4 (the removal of sand from selected borrow sites for Ship Island restoration), (3) Cat Island Restoration (use of the Cat Island borrow site and placement of borrow material at Cat Island), and (4) Littoral Placement of Dredged Material (the revised management of dredged material from the Federal Pascagoula Ship Channel at DA-10). Three additional borrow site combinations to support the proposed restoration at Ship Island (Borrow Site Options 1, 2, and 3) are evaluated as Other Alternatives Considered. These combinations are summarized in Table 5-1 and described in more detail in Section 3.4.2.

TABLE 5-1
Summary of Borrow Site Options for Ship Island Restoration

	Potential Borrow Sites for Camille Cut and East Ship Island Restoration (mcy of sand)						
Borrow Site Options	**PBP-AL**	**DA-10 /Sand Island**	**Ship Island**	**Horn Island**	**PBP-MS**	**PBP-OCS**	**Cost ($ million)**
Borrow Site Option 1	12.2	5.1	1.2	0	0	0	$402
Borrow Site Option 2	3.4	5.1	1.2	3.2	2.0	4.1	$330
Borrow Site Option 3	4.8	3.7	1.2	3.2	2.0	4.1	$341
Borrow Site Option 4	8.5	0	1.2	3.2	2.0	4.1	$368

This SEIS does not analyze impacts from the ongoing use of DA-10 for disposal of dredged material. The evaluation is restricted to potential impacts from changing the location of primary disposal within DA-10 to a location that better feeds the littoral transport process. An SEIS for the Pascagoula Harbor Navigation Channel, which addresses constructing the navigation project to its federally authorized dimensions, was completed in 2010 and included the use of DA-10.

5.2 Physical Environment

5.2.1 Physiography

Physiography includes physical geography and geology. Potential impacts on physical geography are addressed in Section 5.4.1, and therefore only impacts to geology are addressed in this section. The significance criterion for geology would be a permanent change in underlying bedrock that interferes with the natural movement and deposition of sediments in Mississippi Sound or the OCS.

5.2.1.1 Tentatively Selected Plan

The TSP would cause no temporary or long-term change to geology, including bedrock, in the project area. Therefore, the TSP would have no impacts on the physiography of the project area.

5.2.1.2 Other Alternatives Considered

Use of Borrow Site Options 1, 2, or 3 would not impact geology and would therefore have no impacts on the physiography of the project area.

5.2.1.3 No-Action Alternative

Under the No-Action Alternative, the proposed restoration would not be implemented, and there would be no change in the physiography of the project area. The No-Action Alternative would therefore have no impacts on the physiography of the project area.

5.2.2 Meteorology

The significance criterion for meteorology would be a permanent disruption in the climate or weather patterns in the proposed project area.

5.2.2.1 Tentatively Selected Plan

The scale and type of activities associated with the TSP (e.g., construction and related movement of materials) would not change the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.2.2 Other Alternatives Considered

As with the TSP, use of a different borrow site (Borrow Site Options 1, 2, or 3) would result in no change in the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.2.3 No-Action Alternative

Under the No-Action Alternative, the proposed restoration would not be implemented. There would be no change in the climate or weather patterns in the project area. As a result, there would be no impacts on meteorology in the project area.

5.2.3 Hydrology and Coastal Processes

The significance criteria for hydrology and coastal processes would be a permanent disruption in current or tide patterns in Mississippi Sound, the sediment transport system or channel shoaling and frequency of dredging within the Gulfport Navigation Channel.

5.2.3.1 Tentatively Selected Plan

Ship Island Restoration

Under the TSP, the closure of Camille Cut would restore the littoral sediment budget along the restored Ship Island by adding sediment back to a system that has been negatively affected by anthropogenic removal and natural events. Combined with the deposition of sediments along the south shore of the East Ship Island updrift zone, the sediments would be transported along the southern shoreline towards the central part of the restored Ship Island and then towards West Ship Island. Analysis indicates that some sedimentation could occur within a 10- to 15-year time period under average wave climate conditions. However, given the frequency of hurricanes it is likely that sediment accumulation along the island will diffuse throughout the system with only a negligible effect on Ship Island Pass, given the large morphological changes induced by hurricanes (Appendix C). There could be an increase in sedimentation in the pass and outer bar segments of the navigation channel during hurricane events. The larger hurricanes considered in the assessment (Katrina and Georges) resulted in a potential 10 to 30 percent increase in sedimentation in the entrance channel and the smaller hurricanes resulted in a potential 5 to 10 percent increase (Appendix C). Based on historical dredging records, hurricanes have accounted for approximately 23 percent of the channel dredging within the Gulfport entrance channel. The overall increase based on historic records within this segment of the Gulfport channel is anticipated to be less than 4 percent of the overall historic dredging quantity.

Filling Camille Cut would close a hydraulic pathway between East Ship Island and West Ship Island. This would result in a larger flow around the east and west ends of the contiguous island.

The filling of Camille Cut and the restoration of Ship Island would restore a protective barrier and reduce storm waves at the mainland. Modeling of wave changes (Appendix D) indicated that the maximum reduction in wave height at the mainland Mississippi coast ranged from 0.2 to 1.25 meters compared to existing conditions. This reduction in wave height would be a beneficial effect on the coastal mainland.

In summary, the restoration of Ship Island would cause significant changes in hydrology. Because of the resulting changes to littoral transport and storm surge protection, implementation of the Ship Island restoration and closure of Camille Cut would have a significant beneficial effect on hydrologic conditions in Mississippi Sound through the reduction of wave heights on the mainland coast during storm events. The effects of sediment transport from placement of material at East Ship Island and Camille Cut are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass based on the analysis are anticipated to be minor.

Borrow Site Option 4

Removals of sand from the Ship Island, PBP-AL, and Horn Island Pass borrow sites were modeled as part of the modeling assessment of the project area (Appendix C; Appendix D).

Under this analysis, removal at the borrow sites produced a localized reduction in wave energy leeward of the borrow area when compared to existing conditions. However, removal of sand also caused localized increases in wave energy at the fringes of the borrow sites that would result in larger wave heights in the immediate area, but would not have an adverse effect the barrier islands, pipeline infrastructure or the coast (Appendix C; Appendix D; Appendix G). Based on that analysis, the removal of sand from those proposed borrow sites would have long-term minor, and therefore not significant, impacts on the overall hydrodynamics of the area. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium.

Due to the small size (83 acres) and limited excavation depth (8 ft) of the Ship Island borrow site, use of this site would not have, long-term impacts on the overall morphological development of Ship Island. Any changes in waves would lessen and dissipate at the inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix C). These impacts are therefore considered not significant.

The removal of sand from the PBP-AL and Horn Island Pass borrow sites would result in long-term minor, and therefore not significant, impacts on the overall morphology of these areas. These borrow areas are located outside of the island sediment transport system and would not impact nourishment of Dauphin Island or the Mississippi barrier islands (Appendix B and Appendix D). An analysis of 20 years of shoreline change shows negligible difference between the dredged and existing cases for the Horn Island borrow (Appendix D). Analysis of Petit Bois Alabama borrow indicates West Dauphin Island would experience small dredged-induced decreases in erosion and accretion in areas where they occur (Appendix D). Additional analysis of sediment transport and morphological change demonstrated that maintaining a minimum 1,000-foot buffer around the pipeline infrastructure and eliminating two of the eastern most subcuts of the western PBP-AL borrow reduced the potential for significant bathymetric changes along the pipeline (Appendix G). As with the Ship Island borrow site, long-term impacts would lessen and dissipate at inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix D).

Removal of material from the PBP-MS and PBP-OCS borrow sites was not modeled. PBP-OCS sites are located more than 3.5 miles offshore in water depths of 45 to 60 feet. Given the offshore distance and ambient water depths, it is unlikely that use of the potential borrow areas in the OCS would cause impacts from wave refraction or focusing. Furthermore, Byrnes et al. (2004) found minor wave modifications and minor impact of sediment and fluid dynamics from offshore sand extraction at sand mining offshore locations in Alabama. Based on their locations and similarities with sites that have been modeled in Alabama (Byrnes et al., 2004) and as part of the proposed project (Appendix C and Appendix D), only long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area would be expected. As with those locations, the PBP-MS and PBP-OCS borrow areas are located outside of the island sediment transport system and would not impact nourishment of the barrier islands. Impacts to inshore borrow areas would lessen and dissipate as the borrow site slopes flatten and the borrow areas naturally fill in over time.

In summary, removal of material from the borrow areas under Borrow Site Option 4 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area (Appendix C). These impacts would lessen and dissipate at inshore borrow site as the slopes flatten and the borrow areas naturally fill in over time. Sediment transport for barrier island nourishment and coastal areas would not be adversely impacted (Appendix B). No significant impacts to hydrology or coastal processes would occur from implementation of Borrow Site Option 4.

Cat Island Restoration

The removal of sand from the proposed Cat Island borrow area would have long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area. Removal of material from the borrow area would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. Due to the relatively small size and limited excavation depth of the borrow site, use of the site would not be expected to negatively impact the overall morphological development of Cat Island (Appendix D and Appendix E). Long-term impacts would lessen and dissipate at inshore borrow sites as the slopes flatten and the borrow areas naturally fill in over time. Placement of sand at Cat Island would occur primarily on existing upland and beach areas. Therefore, no significant impacts to hydrology or coastal processes would occur from the proposed restoration of Cat Island.

Littoral Placement of Dredged Material

Modification of the continuing placement of dredged material in the combined DA-10 and littoral zone disposal site would provide up to 1 million cubic yards of material into the littoral transport system every 18 months. Future placement of dredged material, in the south and west parts of the disposal area (Figure 3-16) would provide a source of material for sediment transport to the downdrift barrier islands (e.g., Horn Island) (Appendix B). This activity would have a long-term beneficial impact on the availability of sand in the littoral system and island morphology.

5.2.3.2 Other Alternatives Considered

Borrow Site Option 1

Removal of sand from the proposed Ship Island borrow area would result in impacts identical to those described under Borrow Site Option 4 above.

The removal of sand from the PBP-AL borrow area would result in impacts similar to those described under Borrow Site Option 4. Impacts on the overall morphology and hydrodynamics would be greater due to the greater amount of sand that would be removed (12.2 mcy under Borrow Site Option 1 compared to 8.5 mcy under Borrow Site Option 4). These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D).

The removal of sand from the DA-10/Sand Island borrow area would have long-term minor, and therefore not significant, impacts on the overall morphology and hydrodynamics of the area. Past placement of dredged material within the northern portion of DA-10 created a subaerial feature, known as Sand Island. The rate of transport out of this area to feed the downdrift barrier islands (Horn and Ship Islands) is very low. Therefore, the natural rate of sand transport in the system would not be adversely affected by removing sand from this location (Appendix B). Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 50 percent of the subaerial portion of DA-10/Sand Island more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Analysis of wave propagation through Horn Island pass indicates that wave energy is physically obstructed by DA-10/Sand Island. Leaving the southern shoreline of Sand Island intact would continue to provide a buffer to higher gulf wave energy propagating into Mississippi Sound (Appendix D and Appendix F; Chapman et al., 2012).

Overall, removal of material from the borrow areas under Borrow Site Option 1 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

Borrow Site Option 2

Under Borrow Site Option 2, the removal of sand from the proposed borrow areas at Ship Island, Horn Island Pass, PBP-MS, and PBP-OCS would have impacts identical to those described under Borrow Site Option 4.

Impacts at the DA-10/Sand Island borrow area would be identical to those at Borrow Site Option 1.

Borrow Site Option 2 would utilize the least amount of sand from the PBP-AL borrow area (3.4 mcy) compared to the other borrow site options. This would allow for use the eastern PBP-AL borrow site, which is located the furthest away from the pipeline infrastructure. With the smaller area that would be dredged, this option would result in the least amount of impact to coastal processes at this location compared to the other restoration alternatives. Impacts from removal at this location would be minor and long-term, and therefore not significant. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D).

Overall, removal of material from the borrow areas under Borrow Site Option 2 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

Borrow Site Option 3

Under Borrow Site Option 3, impacts at the Ship Island, Cat Island, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas would be identical to those under Borrow Site Option 2.

Impacts at DA-10/Sand Island would be less than those under Borrow Site Options 1 and 2. Under Borrow Site Option 3, 3.7 mcy of sand would be removed compared to 5.1 mcy under Borrow Site Option 2. While a portion of DA-10/Sand Island is within the active littoral zone, the sediment contained within this area was artificially placed by dredging practices. The rate of transport out of this area to feed the downdrift barrier islands (Horn and Ship Islands) is very low compared to the rate in areas where the material would have naturally been transported. Therefore, the natural rate of sand transport in the system would not be adversely affected by removing sand from this location (Appendix B). Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 30 percent of the subarial portion of DA-10/Sand Island more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Analysis of wave propagation through Horn Island pass indicates that wave energy is physically obstructed by DA-10/Sand Island. Leaving the majority of southern shoreline of Sand Island intact would continue to provide some buffer to higher gulf wave energy propagating into the Mississippi Sound. Impacts at PBP-AL, in Borrow Site Option 3 (which would utilize 4.8 mcy of sand from this location), would be greater than impacts of Borrow Site Option 2, but would be less than impacts of Borrow Site Option 1 or 4. As with Borrow Site Option 2, the smaller quantity to be utilized from this site would allow for use the eastern PBP-AL borrow site, which is located the furthest away from the pipeline infrastructure. Impacts from removal at this location would be minor and long-term, and therefore not significant. These effects would be localized and would be reduced over time as the bottom contours gradually reach equilibrium (Appendix D and Appendix F).

Overall, removal of material from the borrow areas under Borrow Site Option 1 would cause long-term localized minor impacts to wave energy, with wave reductions over most of the borrow area and wave increases only at the edges of the borrow area. No significant impacts to hydrology or coastal processes would occur.

5.2.3.3 No-Action Alternative

Under the No-Action Alternative, East and West Ship Islands would continue to narrow and lose land area as a result of updrift erosion (Morton, 2008). Given historical rates of shoreline recession (15 to 20 ft/yr) and associated beach erosion (300,000 to 400,000 cy/yr) along East Ship Island, the island could become a subaqueous shoal within the next decade (Appendix B; Morton et al., 2004).

Cat Island would continue to experience beach erosion and the gradual conversion of upland areas to shallow sub-aqueous areas.

DA-10, including Sand Island, would continue to be used for disposal of dredged material. However, the material would not be placed primarily in the portion of that site within the littoral transport zone. Therefore, the majority of the placed sand would not be transported to downdrift barrier islands.

Without restoration of the barrier islands, wave conditions on the mainland coast would increase from 0.2 to 0.4 meter during storm events (Appendix C). Therefore, under the No-Action Alternative, there would be long-term significant impacts to hydrology and coastal processes.

5.2.4 Bathymetry

The significance criterion for bathymetry would be a permanent change in depth that adversely affects currents, tides and/or natural water movement in Mississippi Sound or OCS.

5.2.4.1 Tentatively Selected Plan

Ship Island Restoration

The TSP would cause a permanent change in bathymetry at East and West Ship Islands. Following restoration, the combined Camille Cut and East Ship Island equilibrated fill areas would encompass approximately 1,500 acres, of which approximately 700 acres would be below the MHWL. Within Camille Cut, subaqueous bottom currently at an elevation averaging -5 feet NAVD88 between West and East Ship Islands would be converted to barrier island habitat.

Analysis indicates that the restoration of the littoral sediment transport system and changes to local currents resulting from the closing of Camille Cut could potentially result in increased sedimentation in the Ship Island Pass over a 10- to 15-year period under average wave climate conditions. However, given the frequency of hurricanes it is likely that sediment accumulation along the island will diffuse throughout the system with only a negligible effect on Ship Island Pass, given the large morphological changes induced by hurricanes (Appendix C). There could be an increase in sedimentation in the pass and outer bar segments of the navigation channel during hurricane events. Larger hurricane events could result in potential 10 to 30 percent increase in sedimentation in the entrance channel, and smaller hurricanes could result in a potential 5 to 10 percent increase (Appendix C). This would require some additional maintenance of the Ship Island Pass after these events, although the overall frequency of dredging would not be expected to increase (Appendix C). Therefore, impacts to required maintenance dredging would not be significant.

Overall, there would be long-term, beneficial, significant changes to bathymetry from the restoration of Camille Cut and East Ship Island. The closure of Camille Cut and the restoration of Ship Island would restore a protective barrier and reduce storm waves at the mainland as described in Appendix C. The effects of sediment transport from placement of material in the East Ship Island and Camille Cut are expected to be localized to Ship Island, and impacts to the Gulfport Navigation Channel in Ship Island Pass are anticipated to be minimal (Appendix C).

Borrow Site Option 4

Borrow Site Option 4 would cause long-term minor changes in bathymetry at the Ship Island, Horn Island Pass, PBP-MS, PBP-AL, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-10, 3-11, and 3-12, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 5-2. As described in Section 5.2.3.1, removal of material from each of the borrow areas in Borrow Site Option 4 would not significantly affect island morphology, the movement of sand, or hydrological processes. The removal of sand would result in long-term minimal, and therefore not significant, impacts on the overall morphology of these areas, as discussed below. Additionally, the slopes of the inshore borrow areas would be expected to flatten and backfill with sand and finer-grained material over time (Appendix C). Therefore, these impacts to bathymetry would not be significant.

TABLE 5-2
Borrow Site Option 4—Size, Current and Post-Dredging Depths

Borrow Area	Size (acres)	Current Average Depth (ft.) NAVD88	Post-dredging Max Depth (ft.) NAVD88
Ship Island	83	-28	-36
PBP-AL	609	-32 to -37	-43 to -48
Horn Island Pass	587	-25 to -36	-34 to -42
PBP-MS	175	-25 to -32	-33 to -48
PBP-OCS	809	-45 to -60	-50 to -68

For the Ship Island borrow site, due to the small size (83 acres) and limited excavation depth (8 ft), use of this site would not have, long-term impacts on the overall morphological development of Ship Island. Any changes in waves would lessen and dissipate at the inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix C). These impacts are therefore considered not significant.

For the Horn Island borrow area, an analysis of 20 years of shoreline change shows negligible difference between the dredged and existing cases (Appendix D).

Analysis of PBP-AL borrow indicates West Dauphin Island would experience small dredged-induced decreases in erosion and accretion in areas where they occur (Appendix D). Additional analysis of sediment transport and morphological change demonstrated that maintaining a minimum 1,000-foot buffer around the pipeline infrastructure and eliminating two of the eastern most subcuts of the western PBP-AL borrow reduced the potential for significant bathymetric changes along the pipeline (Appendix G). As with the Ship Island borrow site, long-term impacts would lessen and dissipate at inshore borrow sites, as slopes flatten and the borrow area naturally fills in over time (Appendix D).

Cat Island Restoration

At Cat Island, approximately 305 acres of eastern shoreline and nearshore areas of Cat Island would be filled and converted to upland habitat. This placement would address ongoing erosion and would result in beneficial impacts to Cat Island.

Removal of material for placement on Cat Island would cause a long-term change in bathymetry at the Cat Island borrow area (Figure 3-4). Near Cat Island, bottom depth would increase by approximately 5 feet to a depth of approximately -20 feet NAVD88 (from current average depths of -15 feet NAVD88) across an area of approximately 282 acres. Modeling of removal sites associated with the Ship Island restoration found no significant impacts (Appendix D), and modeling results would be expected to be similar at the Cat Island borrow site (Appendix E). The slopes of the inshore borrow area would be expected to flatten and backfill with sand over time. Therefore, bathymetric impacts would not be significant.

Littoral Placement of Dredged Material

DA-10 would continue to be used for disposal of material from the Pascagoula Harbor Navigation Channel. However, placement would primarily occur in a different part of the site. This continued use, focused in the south and west parts of the disposal area (Figures 3-15 and 3-16) would maintain bathymetry that is conducive to sediment transport to the downdrift barrier islands.

5.2.4.2 Other Alternatives Considered

Borrow Site Option 1

Borrow Site Option 1 would cause long-term changes to bathymetry in the Ship Island, DA-10/ Sand Island, and PBP-AL sediment borrow areas (Figure 3-5, 3-7, and 3-10, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 5-3. The removal at DA-10/Sand Island would include the removal and permanent conversion of 105 acres of existing island habitat to submerged land. The removal would not result in significant changes in currents, tides, or natural water movement in Mississippi Sound (Appendix D and Appendix F). Furthermore, as described in Section 5.2.3.2, removal of material would significantly affect island morphology, the movement of sand, or hydrological processes. The slopes of the inshore borrow areas would be expected to flatten and backfill with sand and finer-grained material over time (Appendix C). Therefore, these impacts to bathymetry would not be significant.

TABLE 5-3
Borrow Site Option 1—Size, Current and Post-Dredging Depths

Borrow Site	Size (acres)	Current Depth (ft.) NAVD88	Post-dredging Max Depth (ft.) NAVD88
Ship Island	83	-28	-36
PBP-AL	885	-30 to -37	-37 to -48
DA-10/Sand Island	357	+18 to -7	+6 to -12

Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 50 percent of the subarial portion of DA-10 more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

Borrow Site Option 2

Borrow Site Option 2 would cause a long-term change in bathymetry at the Ship Island, Horn Island Pass, DA-10/Sand Island, PBP-AL, PBP-MS, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-7, 3-10, 3-11, and 3-12, respectively). The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 5-4.

TABLE 5-4
Borrow Site Option 2—Size, Current and Post-Dredging Depths

Borrow Site	Size (acres)	Current Average Depth (ft.) NAVD88	Post-dredging Max Depth (ft.) NAVD88
Ship Island	83	-28	-36
PBP-AL	490	-31 to -37	-43 to -48
Horn Island Pass	587	-25 to -36	-34 to -42
PBP-MS	175	-25 to -32	-33 to -48
PBP-OCS	809	-45 to -60	-50 to -68
DA-10/Sand Island	357	+18 to -7	+6 to -12

Impacts to the Ship Island, Horn Island Pass, PBP-MS, PBP-AL, and PBP-OCS borrow sites would be similar to those described under Borrow Site Option 4.

Impacts to the DA-10/Sand Island borrow area would be similar to those described under Borrow Site Option 1.

As described in Section 5.2.3.2, removal of material would not significantly affect island morphology, the movement of sand, or hydrological processes. The slopes of the inshore borrow areas would be expected to flatten and backfill with sand and finer-grained material over time (Appendix C).Therefore, these impacts to bathymetry would not be significant.

Borrow Site Option 3

Borrow Site Option 3 would cause long-term changes in bathymetry at the Ship Island, Horn Island Pass, DA-10/Sand Island, PBP-AL, PBP-MS, and PBP-OCS borrow sites (Figures 3-5, 3-6, 3-8, 3-10, 3-11, and 3-12, respectively). Impacts at these locations would be similar to those that would occur under Borrow Site Option 2. The maximum sizes of the areas that could be affected and the maximum new depths that could occur post-dredging are shown in Table 5-5.

TABLE 5-5
Borrow Site Option 3—Size, Current and Post-Dredging Depths

Borrow Site	Size (acres)	Current Average Depth (ft.) NAVD88	Post-dredging Max Depth (ft.) NAVD88
Ship Island	83	-28	-36
PBP-AL	490	-31 to -37	-43 to -48
Horn Island Pass	587	-25 to -36	-34 to -42
PBP-MS	175	-25 to -32	-33 to -48
PBP-OCS	809	-45 to -60	-50 to -68
DA-10/Sand Island	304	+18 to -7	+6 to -12

At the DA-10/Sand Island borrow area, the removal would include the permanent conversion of 58 acres of existing upland habitat to submerged land. The removal would not result in significant changes in currents, tides, or natural water movement in Mississippi Sound (Appendix D and Appendix F). Furthermore, the slopes of the inshore borrow areas would be expected to flatten and backfill with sand over time. Therefore, these impacts would not be significant.

Hydrodynamic and sediment transport analysis indicates that tidal flows through Horn Island pass are more channelized and sediment transport potential between DA-10/Sand Island and Petit Bois Island is higher with the current location of Sand Island (Appendix D and Appendix F). This increase in channel velocities has likely contributed to the scour in and near the channel up to 20 feet deeper than the authorized channel depths (Appendix B). With the removal of over 30 percent of the subarial portion of DA-10 more area for tidal flow to pass through the inlet would be provided, which could result in less flows and souring within the inlet channel.

5.2.4.3 No-Action Alternative

Under the No-Action Alternative, changes in bathymetry would occur along the barrier islands as a result of continuing erosion and land loss. Relative sea level rise would cause already eroded portions of the barrier islands such as those next to Camille Cut to further erode, altering bathymetry around the islands, due to disruption of island-forming processes (such as the natural sediment transport). The coastline retreat due to historic rates of relative sea level rise has been estimated at about 0.76 ft/yr (0.25 meter/yr) (Appendix C).

Cat Island would continue to experience beach erosion and the gradual conversion of upland areas to shallow sub-aqueous areas.

DA-10/Sand Island and the littoral zone would continue to be used for disposal of dredged material. The material would not be placed primarily in the portion of the sites within the littoral transport zone to transport sand downdrift barrier islands, resulting in the continued alteration of sediment availability and sediment transport to the downdrift islands.

5.2.5 Sediment Characteristics

The significance criteria for sediments would be a change in sediment characteristics that results in a permanent decline in sediment quality; a change in grain size permanently impacting biological communities; a permanent decline in water quality as a result of sediment/water interactions; or a decline in sediment quality that causes permanent impacts to biological resources.

For all components of the TSP, as well as the other alternatives considered, sediment quality would not be impacted. USACE would coordinate all work activities at the restoration areas with the USCG and other appropriate entities. Should USACE discover the presence of an oil substance, including tar balls, the USCG would be notified along with other appropriate agencies for appropriate action and clean-up activities. Consequently, no significant impacts to sediment quality would be anticipated.

5.2.5.1 Tentatively Selected Plan

As summarized in Section 3.2.1.1, beach sand compatibility investigations were conducted to characterize the beach sand on the barrier islands and sand from prospective borrow sites. Samples of beach sand were analyzed for color, angularity, grain size (based on diameter), and gradation (Table 3-1). For compatibility with the native material on the island and fill stability, well sorted to poorly sorted subangular sands, light gray to gray in color, with median grain size greater than 0.28 mm and percent fines less than 10 percent were considered to be optimum for barrier island restoration efforts. Other material was considered provided that the overfill ratio, which is a principal value in comparing the general suitability of fill material, as a function of grain size compatibility, was equal to or less than 1.3. The sediments placed on Ship Island and Cat Island were selected based on these criteria.

Ship Island Restoration

The sediments placed on Ship Island would be consistent in grain size, as measured by the D50 size, and color found on the existing East Ship Island and West Ship Island (Appendix A). The sediment used for the final application, removed from the Ship Island borrow area, would be similar in color, but slightly smaller in grain size. The placement of material would not negatively impact the overall sediment characteristics of the restored Ship Island.

Borrow Site Option 4

Borrow Site Option 4 would result in long-term reductions in the amount of sediment at the Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island borrow areas. The slopes of inshore borrow areas would be expected to flatten and backfill over time (Appendix D). The overall characteristics of the sediment already present would not be impacted. Because it is more mobile through wave action and ocean currents, the backfill could consist of finer-grained material, resulting in a shift to a greater amount of silts and clays in the borrow areas. Such material would be native to the area and would not cause significant impacts.

Cat Island Restoration

The sediments placed on Cat Island would be consistent in color and grain size, although slightly finer as measured by the D50 size, with the sediments currently found on Cat Island. The placement of material would not negatively impact the overall sediment characteristics of the restored island.

Littoral Placement of Dredged Material

Modification of the placement of dredged material at the combined DA-10/littoral zone site would not result in changes to sediment characteristics or sediment quality. As a result, there would be no impacts on sediment in the project area.

5.2.5.2 Other Alternatives Considered

Borrow Site Option 1

Borrow Site Option 1 would result in a reduction in the amount of sediment present at the current DA-10/Sand Island site; however, dredged sediment would continue to be added to the modified DA-10/littoral zone site, which is in the active littoral drift area, every 18 months in the amount of approximately 1 mcy. Borrow Site Option 1 would result in long-term reductions in the amount of sediment at the PBP-AL, Cat Island, and Ship Island borrow areas. The overall characteristics of the sediment already present would not be impacted. For the same reasons noted in the discussion of Borrow Site Option 4, backfill would be native to the area and would not cause significant impacts.

Borrow Site Option 2

Under Borrow Site Option 2, there would be a reduction in the amount of sediment present at DA-10/Sand Island, as discussed under Borrow Site Option 1 and long-term reductions in the amount of sediment at the Horn Island Pass, PBP-AL, PBP-MS, PBP-OCS, and Ship Island borrow areas. The overall characteristics of the sediment already present would not be impacted. For the same reasons noted in the discussion of Borrow Site Option 4, backfill would be native to the area and would not cause significant impacts.

Borrow Site Option 3

Borrow Site Option 3 would cause impacts similar to those that would occur under Borrow Site Option 2.

5.2.5.3 No-Action Alternative

Under the No-Action Alternative, there would be no changes in sediment characteristics.

5.3 Water Quality

The significance criteria for water quality would be a permanent change in water quality from organic and inorganic chemicals; and/or a temporary change in water quality that results in the loss of a commercially viable or protected species, loss of foraging habitat for coastal birds, or loss of important habitats (e.g., SAV).

5.3.1 Tentatively Selected Plan

5.3.1.1 Ship Island Restoration

Potential impacts on water quality associated with the restoration of Ship Island could occur during sand placement activities and post-restoration through the closure of Camille Cut.

Changes in DO and nutrients could occur due to mixing and release of sediments into the water column during sediment placement. DO could be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the placement areas. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around the placement areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish. During construction, turbidity levels around the placement locations would be monitored, as appropriate, to confirm that turbidity levels outside the 750-foot mixing zone do not exceed the background turbidity levels by more than the typical state standard of 50 NTUs. Modeling of impacts indicates that exceedances of the standard outside the mixing zone could occur (Appendix C). MDEQ can grant exemptions to the turbidity standard in cases of emergency to protect public health and welfare, and for environmental restoration projects. A waiver could be required and will be requested. Project activities that would result in reasonable and temporary deviations from the standard are allowed if approved by MDEQ (MDEQ, 2007).

Existing SAV areas are located on the Sound side of West and East Ship Islands (Appendix H), and the sand placement would occur on the Gulf side of Ship Island. Therefore, the potential for direct impacts on SAV areas from sand placement and associated turbidity would be limited. However, during short periods of construction (i.e., less than 2 percent of the simulated 2-week time period or less than 1 week of the Phase 1 construction period) turbidity plumes could approach or exceed the state standard within the SAV areas. This is based on conservative estimates utilizing the material containing the highest percent fines within the borrow site (see Appendix C for details on turbidity modeling). Turbidity modeling analysis of placement activities identified no exceedances of the state standard using average borrow material characteristics. To avoid potential turbidity impacts, the amount of fines would be managed during borrow material collection, either through overflowing the hopper dredge (to allow fines to be removed) or by avoiding locations within borrow areas with higher fines content when placement is occurring in the vicinity of existing SAV areas. In the event that such BMPs are deemed necessary, the USACE will install a turbidity barrier similar to that used during the implementation of the West Ship Island northshore sand placement activities.

To assess the potential for water quality effects post-restoration of Ship Island and the closure of Camille Cut, ERDC developed a hydrodynamic (CH3D) and water quality model (CEQUAL-ICM) of the study area to evaluate potential changes in circulation and water quality in Mississippi Sound (Appendix D). The following three scenarios were considered:

1. Base conditions (Pre-Katrina)
2. East Ship Island eroded to -1 ft NAVD88 (without the TSP)
3. Ship Island restored (with the TSP)

A fourth scenario was simulated to look at cumulative impacts, which is discussed further is Section 5.14 of the SEIS and Appendix D. Results were evaluated at three main locations, including Station 2 in the northwest Sound south of Bay St. Louis, Station 5 in the central Sound south of Biloxi Bay, and Station 10 near the mainland Harrison County beach north of Ship Island near Gulfport, Mississippi (Table 5-6). Changes in DO, chlorophyll *a*, and salinity were evaluated at each station described (Appendix D).

TABLE 5-6
Maximum Percent Change for DO, Chlorophyll *a*, and Salinity

	DO Max & Min % Change			Chlorophyll *a* Max & Min % Change			Salinity Max & Min % Change		
Station	**1***	**2***	**3***	**1**	**2**	**3**	**1**	**2**	**3**
2	1.67	1.84	1.50	15.04	21.10	12.11	2.16	2.90	1.43
	-0.18	-0.31	-1.85	-3.71	-3.15	-4.09	-8.42	-8.76	-8.41
5	8.85	9.50	9.29	48.95	51.23	49.53	7.72	8.17	8.02
	-1.59	-1.56	-1.44	-14.08	-11.17	-13.13	-15.24	-14.77	-10.99
10	5.52	5.61	5.53	40.12	41.47	40.71	16.22	17.91	16.90
	-4.53	-5.16	-4.81	-36.37	-36.45	-38.13	-14.83	-13.00	-8.72

*1 = ((Post – Pre) / Pre)*100
2 = ((Eroded – Pre) / Pre)*100
3 = ((Restored – Pre) / Pre)*100

Minus sign indicates scenario value less than “Pre” (base) value

Water quality modeling results showed changes from baseline conditions for all sand placement (restoration) scenarios. In Table 5-6, the percent changes from the base condition (pre-Katrina) are summarized for each scenario for each of the three locations. Positive values represent increases in maximum values from the base case and negative values are decreases in minimum values from the base case. The important variable in this analysis is the magnitude of the percent change.

The restored scenario (number 3) resulted in the least amount of salinity change at all three locations compared to pre-Katrina conditions. At Station 2, in the northwest part of the Sound in the vicinity of the major oyster reefs, the modeling indicates that the maximum salinity levels remain near pre-Katrina conditions (1.4 percent increase) while the minimum salinity levels drop by approximately 8.4 percent. Under the eroded scenario (number 2), salinity variations increase more than under the restored scenario at all three locations in the Sound (Table 5-6). This modeling suggests that further degradation of the barrier islands results in regional increases in salinity inland of Ship Island. The closure of Camille Cut would reduce the movement of higher-salinity water into the Sound, resulting in salinities near pre-Katrina conditions (see Appendix D).

DO changes under the restored scenario were greatest in the central of the Sound (Station 5), with an overall increase in DO as a result of the increased chlorophyll *a* levels and associated photosynthesis. In the northwest Sound (Station 2), the DO changes were less substantial, with changes from pre-Katrina conditions of only a 1.5 percent increase to a 1.85 percent decrease. North of Ship Island near Gulfport (Station 10), the percent change in DO levels was approximately a 5 percent increase and decrease (Table 5-6). Overall, the impacts to average DO levels from restoration of Camille Cut would be minor, and therefore not significant. Modeling results indicate that DO levels would remain within the Mississippi state standards for ocean waters (or a daily average of not less than 5.0 mg/L with an instantaneous minimum of not less than 4.0 mg/L) (Appendix D). Chlorophyll *a* changes for the restored scenario showed a greater range than the other parameters, with increases from 12.1 percent at Station 2 to 40.7 percent at Station 10 and decreases ranging from 4.09 percent at Station 2 to 38.12 percent at Station 10. Overall, the modeling indicates that the restored scenario (with the TSP) would not have significant impacts on water quality and would produce water quality conditions close to pre-Katrina conditions in the Sound.

The potential water quality impacts are summarized below:

- Placement Activities – There would be temporary and minor impacts during placement activities, primarily due to increased turbidity in the immediate vicinity of construction activity. SAV areas are located north and west of East Ship and West Ship Islands and would be unlikely to be directly affected by placement activities. In addition, monitoring for turbidity levels would be used to identify the potential for impacts on SAV areas and appropriate turbidity barrier would be used around sensitive habitats, if needed. Additional practices to minimize water quality impacts would include plantings of native vegetation to stabilize new barrier island habitat areas, inspection of construction equipment for leaks, and establishment of containment areas for the storage of equipment fuels and lubricants. No significant water quality impacts would be anticipated from placement activities.

- Post-Restoration – There would be beneficial impacts on salinity in the Sound by restoring the structure (i.e., an intact barrier island) that prevents saltwater exchange with Mississippi Sound. Reducing saltwater exchange through Camille Cut would help to maintain estuarine conditions. Compared to the No-Action Alternative, the TSP would better protect the estuarine regime required by oysters and other estuarine-dependent species (see Section 5.4.3). Minor changes in DO and chlorophyll *a* would not be significant based on the modeling results.

5.3.1.2 Borrow Site Option 4

Potential impacts on water quality associated with Borrow Site Option 4 would occur during dredging at the Ship Island, PBP-AL, Horn Island, PBP-MS, and PBP-OCS borrow sites.

During sediment removal, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment removal and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the removal. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around borrow areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish.

Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.1.3 Cat Island Restoration

Potential impacts on water quality associated with the restoration of Cat Island could occur during sand borrow placement activities.

During sediment dredging and placement activities, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment dredging and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the borrow and placement areas. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around the placement areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish. During construction, turbidity levels around the placement locations would be monitored, as appropriate, to confirm that turbidity levels outside the 750-foot mixing zone do not exceed the background turbidity levels by more than the typical state standard of 50 NTUs. Modeling of impacts indicates that exceedances of the standard outside the mixing zone could occur (Appendix C). MDEQ can grant exemptions to the turbidity standards in cases of emergency to protect public health and welfare, and for environmental restoration projects. A waiver could be required and will be requested. Project activities that would result in reasonable and temporary deviations from the standard are allowed if approved by MDEQ (MDEQ, 2007).

In summary, there would be temporary and minor impacts during placement and dredging activities, as demonstrated by the water quality modeling, primarily due to increased turbidity in the immediate vicinity of construction activity. SAV areas are located north, south, and west of Cat Island and would not be directly affected by placement activities on the eastern beach. However, monitoring for turbidity levels would be used to identify potential for impacts on SAV areas and appropriate turbidity barrier would be used around sensitive habitats, if needed. Additional practices to minimize water quality impacts would include plantings of native vegetation to stabilize restored barrier island habitat areas, inspection of construction equipment for leaks, and establishment of containment areas for the storage of equipment fuels and lubricants. No significant water quality impacts would be anticipated from placement activities.

5.3.1.4 Littoral Placement of Dredged Material

Modification of dredged material placement into the combined DA-10/littoral zone site would not result in changes to water quality.

5.3.2 Other Alternatives Considered

5.3.2.1 Borrow Site Option 1

Potential impacts on water quality associated with Borrow Site Option 1 would occur during dredging at the Ship Island, PBP-AL, and DA-10/Sand Island.

During sediment removal, temperature, salinity, and DO profiles would be affected as a result of water column mixing. However, profiles would return to background conditions following completion of activities. Any impacts to these water quality profiles would be temporary and minor. Changes in DO and nutrients could also occur due to mixing and release of sediments into the water column during sediment removal and placement. DO concentrations could decrease during and immediately following dredging due to the movement of low-DO water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Any impacts would likely be restricted to the immediate vicinity of the removal. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor, and therefore not significant.

Construction could temporarily impact localized turbidity around borrow areas. The generation of turbidity could reduce light penetration through the water column, thereby reducing photosynthesis and affecting surface water temperatures and aesthetics in the vicinity. These conditions could also alter visual predator-prey relations and result in respiratory stresses in fish.

Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.2.2 Borrow Site Option 2

Impacts associated with Borrow Site Option 2 would be similar to those that would occur under Borrow Site Option 1 with the following exceptions. Additional minor temporary impacts to water quality during sand removal, similar to those described in Borrow Site Option 1, would also occur during removal activities at the Horn Island, PBP-MS, and PBP-OCS borrow sites. The temporary and minor impacts during borrow activities would be fewer at the PBP-AL borrow area compared to removal at that location under Borrow Site Option 1, due to the reduced amount of material that would be obtained from that location--3.4 mcy under Borrow Site Option 2 versus 12.2 mcy under Borrow Site Option 1. Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.2.3 Borrow Site Option 3

Impacts associated with Borrow Site Option 3 would be similar to those that would occur under Borrow Site Option 2 with the following exceptions. At PBP-AL borrow area, 4.8 mcy would be obtained under Borrow Site Option 3 versus 3.4 mcy under Borrow Site Option 2, resulting in greater potential for water quality impacts at the site. Volumes at DA-10/Sand Island would be 5.1 mcy under Borrow Site Option 2 compared to 3.7 mcy under Borrow Site Option 3, resulting in a reduced potential for water quality impacts at that site. Because impacts would be temporary and localized, no significant water quality impacts would be anticipated from the borrow activities.

5.3.3 No-Action Alternative

Under the No-Action Alternative, salinity would increase in the Sound over time as more high-salinity Gulf waters are pushed into the Sound through the expansion of Camille Cut and the continued loss of island mass. These changes in salinity would have a negative impact on oyster reefs in the Sound (see Section 5.4.3). In addition, the continued loss of barrier island area would result in additional surge and wave impacts on coastal mainland and wetland habitat (see Sections 5.2.1 and 5.2.3 and Appendix C). These impacts would be likely to reduce the overall area of wetlands available to filter upland runoff before it enters the Sound, and water quality could be impacted over time.

5.4 Biological Resources

Except where noted in specific sub-sections below, the significance criterion for biological resources would be a permanent change in one of the following:

- Health of populations: changes in biomass
- Community structure and composition: changes in the number or kinds of species
- Trophic structure: changes in proportion of various trophic levels and functional feeding groups
- System function: changes in productivity and material cycling

The following sections evaluate the biological effects associated with sediment borrow and placement.

5.4.1 Coastal Habitats

As noted in Section 4.5.1, coastal habitats in the proposed area include both barrier island barrier island beaches, dry beach and dune systems on barrier islands, coastal wetlands, wet habitats on barrier islands, SAV, estuarine shrublands, coastal forests, and mainland beaches. Impacts to affected habitats are discussed below.

5.4.1.1 Tentatively Selected Plan

Ship Island Restoration

Placement of dredged material on the nearshore and frontal dune area of East Ship and West Ship Islands would result in short-term disruption to barrier island beach habitats (i.e., barrier island beaches and dry beach and dune systems) and associated flora and fauna within the footprint of the construction areas, including the loss of 12.75 acres of marine intertidal habitat and 1.3 acres of estuarine intertidal habitat. Although flora and fauna occupying these habitats would be lost, the various habitats would become re-established and re-colonized following restoration. Losses would be ongoing during the entire project construction period, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as construction in a given area is completed and would continue during the post-construction period.

Placement of sand in Camille Cut would result in the permanent loss of approximately 800 acres of nearshore open water habitat at that location. Upon completion of restoration, the amount of coastal habitats, which could include barrier island beaches, and dry beach and dune systems, and eventually wet habitats, estuarine shrublands, coastal forests, would be increased on East Ship and West Ship Islands. Coastal flora and fauna would be beneficially impacted by the addition of approximately 800 acres of new beach habitats from the placement of sand in and revegetation of Camille Cut and degraded beach habitats on East Ship Island. The restored barrier island would provide greater protection to coastal habitats in Mississippi from the intensity of storm surges and storm waves, as well as saltwater intrusion into freshwater systems.

Placement of dredged material could result in temporary disruption to the unconsolidated shoreline habitat (swash zone habitat) in the vicinity of the placement activities. Such effects could cause temporary direct impacts to reproduction and foraging habitats for wildlife. Placement could also create a short-term impact to both habitat and available nutrients for marine invertebrates, fishes, and wading birds.

Closure of Camille Cut between East Ship and West Ship Islands would result in a long-term beneficial impact from the creation of 93.39 acres of unconsolidated shoreline habitat for a net gain of 67.82 acres of such habitat (Appendix M). In addition, the restored barrier islands would sustain the productive estuary of Mississippi Sound as well as provide a greater protection to coastal wetland habitats in Mississippi from the intensity of storm surges and storm waves.

Direct placement of materials could damage SAV areas through smothering or drift of suspended sediments onto plants if the material were placed in their vicinity. However, no SAV beds have been mapped in locations proposed for sediment removal or placement (Vittor and Associates, 2011). Placement of sand near, but not directly in, the current SAV areas as part of the TSP has the potential to provide a long-term benefit through an increase in the areas available for colonization of SAV. Restoration of Ship Island could further enhance potential habitat for SAV in the newly protected littoral areas that would occur north of Camille Cut (Appendix D).

Staging of construction equipment would not occur in areas of mapped SAV. However, construction activities could result in temporary disruption and negligible impacts to nearby SAV as a result of increased turbidity (Appendix C). Best management practices and monitoring as described in Section 5.3 would be implemented to prevent impacts to SAV.

Potential impacts to coastal habitats are summarized below:

- Significant beneficial impacts would occur from a change in habitat type at Camille Cut and restoration of East Ship Island. Approximately 800 acres of open water habitat would be lost and 800 acres of new beach and barrier island habitats would be created, resulting in greater protection for coastal habitats and an increase in less common barrier island habitat.
- Short-term to long-term minor impacts would occur to barrier island beach vegetation. These losses would occur at the tips of East Ship and West Ship Islands around Camille Cut. Re-vegetation would occur via plantings and natural recruitment on newly added upland. Therefore, these impacts are not significant.
- Temporary to short-term moderate impacts to unconsolidated shoreline habitat (swash zone habitat) would occur in the vicinity of the placement activities. Marine invertebrates, fishes, and wading birds could be affected until completion of construction activities. Because these impacts would be temporary to short-term, and because there would be a net increase in shoreline habitat after construction, these impacts are not significant.
- Long-term, moderate, beneficial impacts to SAV would occur from the addition of potential new habitat for colonization.

Borrow Site Option 4

Under Borrow Site Option 4, no impacts to coastal habitats would occur.

Cat Island Restoration

Placement of sandy material on the frontal dune area of Cat Island would result in short-term disruption to barrier island beach habitats (i.e., barrier island beaches and dry beach and dune systems) and associated flora and fauna within the footprint of the construction areas, including 2.52 acres of marine intertidal habitat. Although flora and fauna occupying these habitats would be lost, the various habitats would become re-established and re-colonized following restoration. Losses would be ongoing during the entire restoration project construction period, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as construction in a given area is completed and would continue during the post-construction period.

Upon completion of restoration, the amount of beach habitats, which could include barrier island beaches, dry beach and dune systems, and eventually wet habitats, would be increased on Cat Island. Approximately 305 acres of currently degraded beach habitats would be enhanced by restoration activities, including an expanded shoreline and planting of native beach and dune vegetation. In addition, the restored barrier island would provide greater protection to coastal habitats in Mississippi from the intensity of storm surges and storm waves, as well as saltwater intrusion into freshwater systems.

Placement of sandy material on Cat Island would result in the loss of 2.13 acres of unconsolidated shoreline habitat and could result in temporary disruption to adjacent unconsolidated shoreline habitat (Appendix M). Such effects could cause temporary direct impacts to reproduction and foraging habitats for wildlife. This could create a short-term impact to both habitat and available nutrients for marine invertebrates, fishes, and wading birds.

The restored barrier island would provide greater protection to coastal wetland habitats in Mississippi from the intensity of storm surges and storm waves, as well as saltwater intrusion into freshwater systems.

Potential impacts to coastal habitats are summarized below:

- Short-term minor impacts to barrier island beach vegetation would occur. Re-vegetation would occur via plantings and natural recruitment on newly added upland. Long-term beneficial impacts would include restoration of 305 acres of beach dune habitat. Eroding habitat would be restored and coastal habitats would be better protected.
- Temporary to short-term impacts to unconsolidated shoreline habitat (swash zone habitat) would occur in the vicinity of the placement activities. Marine invertebrates, fishes, and wading birds could be affected until completion of construction activities.

Littoral Placement of Dredged Material

The southern portion of DA-10 would continue to be used for disposal of material from the Pascagoula Harbor Navigation Channel in the combined DA-10 and littoral zone site. This continued use, focused in the south and west parts of the disposal area (Figures 3-15 and 3-16), would maintain bathymetry that is conducive to sediment transport to the downdrift barrier islands. Ensuring continual placement within the most active littoral transport system would benefit the biological species that utilize the barrier island system.

5.4.1.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, removal of material from DA-10/Sand Island would result in the long-term to permanent loss of approximately 105 acres of island habitat (i.e. the man-made Sand Island located within DA-10). Sand Island contains a variety of barrier island habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune. These habitats support a variety of wildlife, including mammals, reptiles, and resident and migratory birds. Approximately 60 acres of island habitat at Sand Island would remain after sediment removal. Although the loss of 105 acres of habitat at DA-10/Sand Island is considered by the NPS a significant impact to emergent wetland resources, the creation of 800 acres of new island conditions at Ship Island would represent a net increase of 695 acres of opportunity for marine intertidal habitat development.

Borrow Site Option 2

Impacts to coastal habitats under Borrow Site Option 2 would be identical to those under Borrow Site Option 1.

Borrow Site Option 3

Impacts to coastal habitats under Borrow Site Option 3 would be similar to those under Borrow Site Option 2 with the exception of potential impacts to DA-10/Sand Island.

Removal of material from this area would result in the long-term to permanent loss of approximately 58 acres of upland habitat at Sand Island. Sand Island contains a variety of barrier island habitats, including tidal flats, open beach, vegetated beach dune, tidal marsh, marsh meadow, and interior relic dune. Approximately 107 acres of island habitat would remain on Sand Island after sediment removal. Although the loss of 58 acres of habitat at DA-10/Sand Island is considered by the NPS a significant impact to emergent wetland resources, the creation of 800 acres of new island conditions at Ship Island would represent a net increase of 742 acres of opportunity for marine intertidal habitat development

5.4.1.3 No-Action Alternative

Under the No-Action Alternative, barrier islands would continue to erode, causing the loss and degradation of barrier island habitat and could result in the loss of wetland habitats and SAV (Morton et al., 2004). In addition, the continued loss of barrier island habitat would result in ongoing potential for storm surge and wave damage on the mainland, including coastal and interior wetland habitats.

5.4.2 Plankton

5.4.2.1 Tentatively Selected Plan

Ship Island Restoration

Elevated turbidity levels and decreased light transmission caused by suspended material during placement activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance.

Turbidity and suspended solids were measured as part of a 1975 USACE study of dredging and disposal activities. The study included an evaluation of water quality and plankton in dredge and disposal areas over a 40-square-mile grid centered on the Gulfport Shipping Channel in Mississippi Sound. That study found that plumes from sediments consisting of a mix of silts, clays, and sands were small and localized and that solids tended to settle rapidly. Levels of turbidity and suspended solids, even from sediments with a high percentage of fines, returned to background levels at disposal sites within 2 to 3 hours. Samples were collected before and after dredging activities. No observable effects on the resident plankton community were observed in terms of stimulatory effects, species composition, or community structure (USACE, 1975).

The release of nutrients from sediments during the placement process could indirectly support a localized temporary increase in phytoplankton.

Planktonic organisms would be carried into and out of the project area via currents during and after sediment removal and placement activities. Because impacts would be restricted to localized patches of plankton, any impacts would not be significant. As a result, there would be no potentially adverse change in the health of populations, community structure and composition, trophic structure, or system function.

Borrow Site Option 4

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for the restoration of Ship Island and would occur at the Ship Island, Horn Island Pass, PBP-AL, PBP-MS, and PBP-OCS borrow areas.

Cat Island Restoration

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging and placement activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for the restoration of Ship Island.

Littoral Placement of Dredged Material

Modification to the disposal of dredged material within the combined DA-10/littoral zone site would not result in changes to the plankton community.

5.4.2.2 Other Alternatives Considered

Borrow Site Option 1

Elevated turbidity levels and decreased light transmission caused by suspended material during dredging activities could result in a temporary localized reduction in phytoplankton and zooplankton abundance. Impacts would be similar to those described above for Borrow Site Option 4, but would occur in fewer locations (Ship Island, DA-10/Sand Island, and PBP-AL borrow sites). Impacts would be greater at the PBP-AL borrow location, reflecting the greater amount of material that would be removed from the site under Borrow Site Option 1: 12.2 mcy of sand compared to 8.5 mcy under Borrow Site Option 4.

Borrow Site Option 2

Impacts to plankton under Borrow Site Option 2 would be similar to those for Borrow Site Option 4. However, temporary localized impacts from elevated turbidity levels and decreased light transmission would also occur at DA-10/Sand Island. Impacts would be fewer at the PBP-AL borrow location, reflecting the smaller amount of material that would be removed from the site under Borrow Site Option 2: 3.4 mcy of sand compared to 8.5 mcy under Borrow Site Option 4.

Borrow Site Option 3

Impacts to plankton under Borrow Site Option 3 would be similar to those for Borrow Site Option 2. Impacts would occur in the same locations but would be fewer at the PBP-AL and DA-10/Sand Island borrows areas, reflecting the smaller amount of material that would be removed from the sites under Borrow Site Option 3: 4.8 mcy of sand at PBP-AL compared to 12.2 mcy under Borrow Site Option 1 and 3.7 mcy of sand at DA-10/Sand Island compared to 5.1 mcy under Borrow Site Option 1.

5.4.2.3 No-Action Alternative

No change in existing conditions would occur under the No-Action Alternative.

5.4.3 Benthic Environment

The bottom sediments in Mississippi Sound provide habitat for multiple species of infaunal and epifaunal invertebrates. Dredging and placement activities will cause disturbances in the benthic communities in the placement and borrow areas in which species tend to be either tolerant of disruption or capable of rapidly re-colonizing disturbed areas. Table 5-7 provides a summary in acreages of the submerged areas that will be disturbed in placement and borrow area alternatives.

TABLE 5-7
Total Area in Acres Impacted at the Placement and Borrow Sites

Alternatives	Submerged Acreage Impacted (acres)
Tentatively Selected Plan	2,736
Borrow Option 1	1,325
Borrow Option 2	2,501
Borrow Option 3	2,448

The impacts to the benthic environment at the placement sites will occur at the areas being covered by the placement activities. At the borrow areas, impacts will be directly related to the dredging activities in the submerged bottoms. The benthic species of concern are within these sites include a variety on invertebrates, mollusks, and crustaceans as discussed in Section 4.5.3. The mollusk community is dominated by *Donax sp.* and *Gemmea sp*. (Appendix I and Section 4.4.2). The primary crustaceans found in the area are shrimp, crabs, and amphipods. The sections discuss the impacts to these benthic communities resulting from the placement and dredging activities.

5.4.3.1 Tentatively Selected Plan

Ship Island Restoration

Placement of sediments for restoration uses would cause long-term or permanent impacts to benthic communities as a result of changes in the bottom depth profiles in those locations. Use of staging areas for construction equipment would also temporarily disrupt benthic communities. During staging, both infauna and epifauna invertebrates including mollusks and crustaceans would be displaced.

Placement of sediments for restoration purposes would cause direct impacts to the benthic community. In areas converted to uplands, permanent losses would occur. In littoral placement areas and in newly created littoral habitat, recovery of the communities could range from a few months to several years (Bolam and Rees, 2003; USACE, 1999). There are no oyster or clam beds in the immediate area, so there would be no potential for direct impact on these species. Motile mollusks would likely leave the area during these activities and return after operations cease. The crabs and shrimp are fairly mobile and during placement operations could avoid impact, although there would be some mortality and displacement. Most of these organisms would likely leave the area during placement activities and return after operations cease.

Several studies have shown no significant long-term effects on benthic communities from beach restoration. Saloman and Naughton (1984) studied the effect of beach restoration with offshore excavated sand on the nearshore macorinfauana at Panama City Beach, Florida. They concluded that placement of sand in the nearshore had minor, short-term effects on benthic macroinvertebrates, noting that populations appeared to stabilize within 2 to 3 months after restoration. As noted in previous studies, intertidal benthic assemblages declined in abundance and diversity immediately following restoration. It is reasonable to anticipate some non-motile and motile invertebrate species will be physically affected through placement operations but would recover within a few months (Cutler and Mahadevan, 1982). Non-motile benthic fauna within the area would be destroyed by placement operations, but should repopulate within 12 monthsof project completion (Culter and Mahadevan, 1982; Saloman et al., 1982).

Approximately 800 acres of open water shallow benthic habitat at Ship Island would be converted to a combination of barrier island and intertidal habitat from the placement of material. Given the size of open water habitat within Mississippi Sound (approximately 1,184,000 acres), this permanent loss of benthic habitat would result in a negligible impact to ecosystem function. The addition of barrier island and intertidal habitat would represent a significant increase in this habitat within the barrier island system and would be essentially a replacement of habitats lost since Hurricane Camille in 1969.

Short-term impacts could also occur from the placement of construction equipment, including pipelines and anchoring spuds, and construction of temporary moorings. These areas would be expected to recover within a few months to a few years depending on the extent and duration of construction equipment impacts.

Although benthic organisms would be lost, losses would not be significant because the benthic community would become re-established in areas not converted to upland and these benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations undergoing restoration at any given time. Re-colonization would begin as soon as removal or construction in a given area is completed and would continue during the post-construction period (Saloman et al., 1982).

Borrow Site Option 4

Impacts to benthic invertebrates from removal activities would occur. Dredging sediments for restoration uses would cause direct short-term to long-term disruptions to the benthic community in borrow areas. Such changes would occur due to the loss of organisms and changes in the bottom depth profiles in those locations. During dredging, both infauna and epifauna invertebrates would be displaced. There are no oyster or clam beds in the immediate area, so there would be no potential for direct impact on these species. Motile mollusks would likely leave the area during these activities and return after operations cease. Bivalves and semi-sessile mollusks could be displaced by restoration activities. However, bivalves (through larval recruitment) would re-colonize the area. The crabs and shrimp are fairly mobile and during placement operations could avoid impact, although there would be some mortality and displacement. Most of these organisms would likely leave the area during placement activities and return after operations cease. There would likely be some incidental loss of juvenile crustaceans during placement operations; however, these would represent a very limited portion of the population and not have long-term adverse effects on the crustacean community.

Findings from studies on re-colonization of the benthic substrates vary depending upon the nature of the substrate (Chessa et al., 2007; Newell et al., 2004; Bolam and Rees, 2003; and Bemvenuti et al., 2005). Each of these studies evaluated changes in the benthic community associated with dredging activities. All studies found an initial reduction in the species biomass, composition, and abundance. All studies reported a recovery of species abundance, diversity, and biomass, with the rate of the recovery dependent upon the habitat conditions. Recovery of species abundance and diversity was more readily accomplished than recovery of biomass. Recovery of 86 percent of species diversity can occur within 20 days and full recovery within 80 days (Newell et al., 2004). However, recovery of biomass can take in excess of 18 months. The authors also indicate that there is little evidence of indirect impacts on the community structure outside of the immediate dredging boundaries.

Studies specifically investigating the effects of dredging and sand mining off the Alabama coast found recovery of diversity and abundance within 1 to 3 years, if the removal of sediments does not result in deep pits that cause hypoxic or anoxic conditions. However, overall species composition could take longer to recover. Prior to complete recovery, infaunal communities re-colonizing borrow sites could remain in an early successional stage (Byrnes et al., 2004).

At borrow areas associated with Borrow Site Option 4, approximately 2,263 acres of existing benthic habitat would experience short-term impacts from sediment removal: 83 acres at Ship Island, 587 acres at Horn Island Pass, 175 acres at PBP-MS, 609 acres at PBP-AL, and 809 acres at PBP-OCS. No impacts at the DA-10/Sand Island borrow area would occur.

Although benthic organisms would be lost, the benthic community would become re-established and benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations dredged for borrow material at any given time. Re-colonization would begin as soon as removal in a given area is completed and would continue during the post-construction period (Saloman et al., 1982). Because of the short-term nature of the recovery, impacts would be negligible, and therefore not significant.

Cat Island Restoration

Potential impacts to benthic invertebrates including various species of mollusks and crustaceans from both removal and placement activities would occur. Impacts and recovery would be similar to those described for Ship Island restoration and Borrow Site Option 4 above.

At the Cat Island borrow area, approximately 282 acres of existing benthic habitat would experience short-term impacts from sediment removal. Approximately 305 acres of barrier island and shallow water habitat along the beach at Cat Island would be converted to a combination of restored barrier island and intertidal habitat from the placement of material. Given the size of open water habitat within Mississippi Sound (approximately 1,184,000 acres), any loss of benthic habitat associated with placement activities would result in a negligible impact to ecosystem function. The addition of restored barrier island and intertidal habitat would represent a significant increase in this habitat within the barrier island system and would be essentially a replacement of habitats.

Although benthic organisms would be lost during removal and placement, losses would not be significant.

Littoral Placement of Dredged Material

Modification of the placement of dredged material at DA-10/littoral zone would result in littoral movement of newly placed dredged material; thus, benefiting benthic invertebrates by sustaining the habitat rather than filling from retained dredged material at DA-10/Sand Island as past practices had done.

5.4.3.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, impacts would be similar to those described under Borrow Site Option 4. However, potential impacts to borrow areas would occur over a smaller area.

At borrow areas, approximately 1,325 acres of existing benthic habitat would experience short- to long-term impacts from sediment removal: 83 acres at Ship Island, 885 acres at PBP-AL, and 252 acres at DA-10/Sand Island.

At DA-10/Sand Island, approximately 105 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat. This would result in the creation of a negligible amount of new benthic habitat.

The area of impact would be greater at the PBP-AL borrow area (885 acres) compared to Borrow Site Option 4 (609 acres), reflecting the greater amount of sand that would be removed under Borrow Site Option 1 (12.2 mcy) compared to 8.5 mcy under Borrow Site Option 4. This would cause impacts over a longer duration and greater area and would result in slower recovery of the area.

Although benthic organisms would be lost, the benthic community would become re-established and benthic areas would be re-colonized following restoration. Losses would be ongoing during the entire construction period of the project, but would be limited to the specific locations dredged for borrow material at any given time. Re-colonization would begin as soon as removal in a given area is completed and would continue during the post-construction period (Saloman et al., 1982). Because of the short-term nature of the recovery, impacts would be negligible, and therefore not significant.

Borrow Site Option 2

Under Borrow Site Option 2, impacts would be similar to those described under Borrow Site Option 1. However, potential impacts to borrow areas would occur over a larger area.

At borrow areas within Option 2, approximately 2,501 acres of existing benthic habitat would experience short- to long-term impacts from sediment removal: 83 acres at Ship Island, 587 acres at Horn Island Pass, 175 acres at PBP-MS, 409 acres at PBP-AL, 809 acres at PBP-OCS, and 252 acres at DA-10/Sand Island.

The area of impact would be smaller at PBP-AL (409 acres) compared to Borrow Site Option 1 (885 acres), because 3.4 mcy of sand would be removed compared to 12.2 mcy under Borrow Site Option 1. This would result in impacts occurring over a shorter duration and smaller area and would result in faster recovery of the area.

At DA-10/Sand Island, impacts would be identical to those of Borrow Site Option 1. Approximately 105 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat.

Because of the short-term nature of the recovery that would occur following dredging, impacts would be negligible, and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts would be similar to those described under Borrow Site Option 2. However, potential impacts to borrow areas would occur over a smaller area.

At borrow areas within Option 3, approximately 2,448 acres of existing benthic habitat would experience short-term to long-term impacts from sediment removal: 83 acres at Ship Island, 587 acres at Horn Island Pass, 175 acres at PBP-MS, 409 acres at PBP-AL, 809 acres at PBP-OCS, and 246 acres at DA-10/Sand Island.

Under Borrow Site Option 3, the area of impact at PBP-AL (409 acres) would be the same as under Borrow Site Option 2, but 4.8 mcy of sand would be removed compared to 3.4 mcy under Borrow Site Option 2. This would result in impacts occurring over a longer duration at this borrow area and would result in slower recovery of the area. At DA-10/Sand Island, less material would be removed from a smaller area compared to Borrow Site Option 2: 3.7 mcy from 304 acres versus 5.1 mcy from 357 acres. This would result in impacts occurring over a shorter duration and faster recovery of the area.

At DA-10/Sand Island, approximately 58 acres of new benthic invertebrate habitat would be created from the removal of an equivalent amount of island habitat. This would result in the creation of a negligible amount of new benthic habitat.

Because of the short-term nature of the recovery that would occur following dredging, impacts would be negligible, and therefore not significant.

No-Action Alternative

Continued loss and alteration of coastal ecotone habitat, including intertidal and subtidal habitats used by benthic invertebrate communities, would occur under the No-Action Alternative as a result of continuing erosion of the barrier islands and increasing salinities of Mississippi Sound.

5.4.4 Fish

In addition to the significance criteria described above for biological resources, an additional noise-related significance criterion applies to potential impacts to fish communities. Elevated noise levels that cause permanent or long-term population avoidance of the area; cause a temporary threshold shift or permanent threshold shift in hearing; or cause organ damage or death would also be significant.

5.4.4.1 Tentatively Selected Plan

Ship Island Restoration

Placement of sandy material to create barrier island habitat on Ship Island would result in temporary disruption to the mature fish community in the vicinity. Placement could cause behavioral impairment (e.g., disruption of migration patterns), physical impairment (e.g., turbidity-induced clogging of gills resulting in suffocation, or abrasion of sensitive epithelial tissue), and potentially acute and chronic effects (on growth, reproduction, behavior, etc.) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen, 1996). Specific sites on the barrier islands would be used for placement of clean material; therefore, acute and chronic effects to aquatic organisms related to chemical contaminants would not occur. The closure of Camille Cut would eliminate a direct pathway for fish to move from the Sound to the Gulf side of Ship Island; therefore, some species would have to navigate around the island to move offshore. Potential effects to finfish and shellfish associated with placement activities would largely be related to contact with turbidity plumes (placement-induced elevated concentrations of TSS). Although water column turbidity would increase during placement activities, such effects would be temporary and local. Fish would be expected to return after operations cease. Direct impacts to mature fish would be minor and not significant.

Low-mobility lifestages could be impacted through direct burial during placement of sediment. This could include ichthyoplankton suspended in the water column. Egg, embryonic, and larval stages of finfish would be most susceptible to mortality and injury (Blaxter, 1969, 1974; McGurk, 1986; Black et al., 1988; Chambers et al., 1988). Some incidental losses could occur; however, these would represent a very limited portion of the population, and would not result in long-term adverse effects on the fish community. Any impacts would be minor, and therefore not significant.

Indirect impacts to the food web could occur as a result of the placement. In a study by Bolam and Rees (2003), changes in the benthic community were assessed to determine the effects of a change in community structure on bottom-dwelling or demersal species. The review indicated that, based on benthic and fish diet information, the altered benthic community (dominated by small surface-dwelling taxa representative of the early re-colonizers) offered an enhanced trophic structure for the fish community. Any impacts from sediment placement would be minor, and therefore not significant.

Restoration of Ship Island would result in a short-term negative impact to shallow foraging areas and nursery areas during construction. However, it would also result in long-term beneficial impacts to fish habitat by enhancing shallow foraging areas, nursery areas, and SAV areas around the barrier islands in Mississippi Sound.

Underwater noise would occur in association with placement activities and could trigger avoidance reaction in fish species. Specifically, noise associated with placement could occur from (1) ship/machinery—associated with onboard machinery and propeller and thruster noise, (2) pumps—associated with pump driving the suction through the pipe, (3) collection—associated with equipment operation and collection of material on the sea floor, (4) deposition—associated with the placement of the material within the barge or hopper and at the restoration location, and (5) transport—associated with transport of material up the suction pipe.

Sediment dredging operations produce broadband and continuous underwater noise at levels of 160 to 186 dB relative to (re) 1 microPascal at 1 meter (μPa/m), with peak intensity at frequencies between 5 and 500 hertz (Hz) (Hildebrand, 2003; Compton et al., 2008). Underwater noise levels of marine vessels range from 157 to 182 dB (Kipple and Gabriele, 2007). The entire sound range of dredging is from less than 10 Hz to less than 1,000 Hz (NRC, 2003). Sediment removal and placement activities would be expected to generate similar noise levels.

Fish could encounter removal- and placement-related noise in the areas impacted during restoration of Ship Island and under the borrow site options described below. However, because Mississippi Sound waters and offshore waters near the barrier islands are shallower than the channel, the noise would not propagate as well. Fish have exhibited the ability to hear in the lower frequency ranges (NRC, 2003). For frequencies below 1,000 Hz, fish are likely to show avoidance behavior. Above 1,000 Hz, underwater noise levels provoking avoidance responses decline sharply. As noise levels in the reaction frequency range increase, the range of reaction increases as well (Mitson and Knudsen, 2003). Because the dredging noise would occur at a frequency of around 1,000 Hz, the fish located around the project area could be susceptible to noise and their activity patterns could be disturbed.

Localized temporary impacts would occur during the restoration timeframe from the operation of equipment and vessels in borrow and placement areas. Since most of the project area is within Mississippi Sound, which is shallower than the channel, much of the underwater noise in the lower frequencies would have no potential to affect fish, as those lower frequencies would not propagate. However, the portion of noise that is a higher frequency would be heard and may cause temporary avoidance near operations. As sound propagating through the water column attenuates, the effects would decline logarithmically with distance (NRC, 2003), with the sharpest decline in the first few kilometers from the source. The noise would not occur at levels known to cause injury, temporary or permanent, to fish. Impacts would not be significant.

Potential impacts to fish include:

- Adult fish could experience temporary minor (and therefore not significant) impacts from turbidity plumes and construction-related noise.
- Egg, embryonic, and larval stages of fish could be susceptible to mortality due to placement of material. However, given the amount of habitat and the sizes of fish populations in Mississippi Sound, impacts would be minor, and therefore not significant.
- Benthic habitat and shallow foraging areas/nursery areas in and near Camille Cut would be permanently lost or experience short-term alteration during construction. Foraging areas, including SAV habitat, would be enhanced north of the closed Camille Cut following restoration. Given the amount of habitat available, impacts would not be significant.

Borrow Site Option 4

Temporary impacts and avoidance activities associated with underwater noise would be similar to impacts described under Ship Island restoration above. Removal of material from 2,263 acres at Ship Island, PBP-MS, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS, and 282 acres near Cat Island would result in temporary disruption to the mature fish community in the vicinity. Placement or removal of the material could cause behavioral impairment (e.g., disruption of migration patterns), physical impairment (e.g., turbidity-induced clogging of gills resulting in suffocation, or abrasion of sensitive epithelial tissue), and potentially acute and chronic effects (on growth, reproduction, behavior, etc.) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen, 1996). Water column turbidity would increase during dredging activities and would result in temporary local effects. Fish would be expected to return after operations cease. Direct impacts to mature fish would be minor and therefore not significant.

Cat Island Restoration

Placement of sandy material on Cat Island and removal of material from the 282-acre Cat Island borrow area would result in minor impacts to the mature fish community and incidental losses to low-mobility lifestages in the vicinity of the dredging and placement work, similar to those described in the Ship Island/Borrow Site Option 4 restoration discussion above. As with Ship Island, these impacts would be minor (and therefore not significant).

Littoral Placement of Maintenance Dredged Material

Modification to the placement of dredged material at the combined DA-10/littoral zone site would not result in changes to fish communities.

5.4.4.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, impacts to fish would be similar to those under Borrow Site Option 4 except that temporary disruptions to adult fish, minor losses to low-mobility lifestages, and potential indirect impacts to the food web would only occur at PBP-AL, DA-10/Sand Island, and Ship Island. Fewer locations and a smaller area would be impacted under Borrow Site Option 1 (1,325 acres) compared to Borrow Site Option 4 (2,263 acres). However, impacts would occur over a longer duration and greater area at PBP-AL associated with the greater amount of material that would be removed from that location (12.2 mcy from 885 acres versus 8.5 mcy from 609 acres). Any impacts from sediment removal would be minor, and therefore not significant.

Borrow Site Option 2

Under Borrow Site Option 2, impacts to fish would be similar to those under Borrow Site Option 1 except that temporary disruptions to adult fish, minor losses to low-mobility lifestages, and potential indirect impacts to the food web would occur over a greater area (2,501 acres compared to 1,325 acres under Borrow Site Option 1). Impacts would also occur in more locations, including Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Disruptions would occur over a shorter period at the PBP-AL borrow site compared to Borrow Site Option 1, reflecting the smaller amount of material that would be removed from the site: 3.4 mcy of sand from 409 acres compared to 12.2 mcy from 885 acres under Borrow Site Option 1. Any impacts from sediment removal would be minor, and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to fish would be similar to those under Borrow Site Option 2 and would occur over 2,448 acres. However, disruptions would occur over a longer period at PBP-AL compared to Borrow Site Option 2, reflecting the greater amount of material that would be removed from that location. At PBP-AL, 4.8 mcy of sand would be removed compared to 3.4 mcy under Borrow Site Option 2. At DA-10/Sand Island, a smaller area would be affected and less material removed (246 acres and 3.7 mcy compared to 252 acres and 5.1 mcy under Borrow Site Option 2). Any impacts from sediment removal would be minor, and therefore not significant.

5.4.4.3 No-Action Alternative

Under the No-Action Alternative, barrier islands could continue to erode. This could cause permanent impact from the loss of shallow fisheries nursery habitat around the barrier islands and increasing salinity in the estuarine environment of Mississippi Sound. There would be no impacts to fish at proposed borrow sites.

5.4.5 Marine Mammal Communities

In addition to the significance criteria described above for biological resources, the following significance criteria apply to potential impacts to marine mammal communities:

- A localized loss of a species
- A permanent habitat change that would make the area unsuitable to meet life history requirements

- A disruption that would cause permanent interference with the movement of native resident or migratory marine mammals
- Noise levels that cause permanent or long-term population avoidance of the area
- Noise levels that cause a temporary threshold shift or permanent threshold shift of marine life
- Noise levels that cause stranding, organ damage, or death to marine life

5.4.5.1 Tentatively Selected Plan

Ship Island Restoration

It is unlikely that localized sediment removal and placement operations would affect migration, feeding, or reproduction of marine mammals. Three marine mammals commonly found along the continental shelf of the northern Gulf include Atlantic bottlenose dolphin, Atlantic spotted dolphin, and spinner dolphin (MMS, 2000).

Manatee could occur within Mississippi Sound, but would be unlikely to occur beyond the immediate nearshore coastal areas. Given their slow-moving behavior, manatees could be less likely than other marine mammals to quickly avoid placement operations. However, to minimize contact and potential injury to manatees in shallow water/placement areas, the Manatee Construction Conservation Measures as specified by the USFWS would be observed (Appendix N).

While Atlantic bottlenose dolphin, Atlantic spotted dolphin, and spinner dolphin could pass through the placement and borrow areas associated with the Ship Island restoration, passage would not be geographically restricted to these areas. Other marine mammal species are inhabitants of the deeper waters off the continental shelf and would be unlikely to occur in the location of this alternative. Any species in the vicinity would likely avoid the removal and placement sites during construction and move to other areas within the Sound.

The project area includes no known mating or breeding habitat. No impacts to reproduction would be expected to occur. Any impacts to foraging during removal and placement would be temporary and minor. Impacts would not be significant.

It is unlikely that localized water quality impacts or underwater sounds from conventional dredging and other operations associated with the proposed restoration would cause physical injury to marine mammals. Any animals present in the area upon initiation of activity would be unlikely to remain in the immediate vicinity of the equipment.

Underwater noise would occur in association with the placement and dredging activities as described in the Ship Island discussion of noise with regard to fish above (Section 5.4.4.1). Such noise could trigger avoidance reaction in marine mammals. In some instances, physical auditory damage could occur. Auditory damage would result in reduced hearing sensitivity due to exposure to high-intensity sound and could be either temporary (temporary threshold shift) or permanent (permanent threshold shift) depending on the exposure level and duration. Other than physical damage, the key auditory effect would be an increase in background noise levels, which could cause auditory masking: a diminished ability of an animal to detect a relevant sound signal. Masking of marine mammal vocalizations could disrupt the ability to find prey, navigate, and maintain social cohesion (Compton et al., 2008).

Marine shipping activities produce underwater noise, typically low-frequency sounds in the range of 20-500 Hz, resulting from operation of engines and propellers. Low-frequency sound travels farther underwater than higher-frequency sound (University of Rhode Island, 2003). Vessel propulsion type and horsepower are important factors in the intensity of underwater sound emitted by powered vessels. Sediment dredging operations produce broadband and continuous underwater noise at levels of 160 to 186 dB re 1 μPa at 1 m, with peak intensity at frequencies between 5 and 500 Hz (Hildebrand, 2003; Compton et al., 2008). Underwater noise levels of marine vessels range from 157 to 182 dB re 1 μPa at a distance of 1 meter (3.1 feet) (Kipple and Gabriele, 2007). Since noise decreases with distance, noise levels would be about 40 dB lower at 100 meters and about 53 dB lower at 0.25 mile (Kipple and Gabriele, 2007). The entire sound range of dredging is from less than 10 Hz to less than 1,000 Hz (NRC, 2003). Sediment removal and placement activities would be expected to generate similar noise levels.

Research into impacts on marine mammals has found that prolonged exposure of 140 dB re 1 μPa/m (continuous man-made noise) at 1 km could cause permanent hearing loss. Prolonged exposure of 195 to 225 dB re 1 μPa/m (intermittent noise), at a few meters or tens of meters, could cause immediate hearing damage (Richardson et al., 1995)

Most marine mammals would avoid noisy locations (Richardson et al., 1995), although exposure could occur. A study evaluating specific reaction of bowhead whales to underwater drilling and dredge noise noted that the whales often move away when exposed to drillship and dredge sound; however, the reactions were quite variable and can be dependent on habituation and sensitivity of individual animals (Richardson et al., 1990). Received noise levels would diminish by about 60 dB between the noise source and a radius of 1 km. For marine mammals to be exposed to a received level of 140 dB at a 1-km radius, the source level would have to be about 200 dB re 1 μPa/m. Few human-generated noise sources emit continuous sounds at source levels greater than or equal to 200 dB re 1 μPa/m; however, large vessels such as supertankers and icebreakers could exceed the 195-dB noise level (Richardson et al, 1995).

Hopper dredges would be the noisiest dredges used. Operations from these dredges typically have sustained pressure levels of 120–140 dB at 40 meters from the operating vessel that would likely attenuate significantly with increased distance from the dredge (Clarke et al., 2002). These levels are below the predicted noise effect thresholds noted by Richardson et al. (1995) and fall within the range of background noises that already exist in the environment of Mississippi Sound and the OCS. In addition, marine mammals would be able to move away from the immediate noise sources. Noise generated by dredge and placement activities would not be expected to affect the migration, nursing/breeding, feeding/sheltering, or communication of marine mammals. Although behavioral effects could occur (such as a whale changing course to move away from a vessel), the number and frequency of vessels present in a given portion of the project area would be small and any behavioral impacts would be expected to be minor, and therefore not significant.

For hopper dredging activities, endangered species observers would be on board and would record all whale sightings and note any potential behavioral impacts. In accordance with the standard USACE specifications for dredging projects, the USACE and the observer would record the date, time, and approximate location of all marine mammal sightings. Care would be taken not to closely approach any whales, manatees, or other marine mammals during removal operations or transport and placement of dredged material. An observer would serve as a lookout to alert the dredge operator or vessel pilot or both of the occurrences of the animals. If any marine mammals are observed during other operations, including vessel movements and transit to the dredged material disposal site, collisions would be avoided either through reduced vessel speed, course alteration, or both. During the evening hours, when there is limited visibility from fog, or when there are sea states of greater than Beaufort 3, the dredges would reduce speed to 5 knots or less when transiting between areas if whales have been spotted within 15 nautical miles of the vessel's path in the previous 24 hours. Sightings of whales or manatees (alive, injured, or dead) during the project would be reported to the NMFS Whale Stranding Network.

Localized potential temporary impacts would occur during the restoration timeframe from operation of equipment and vessels in borrow and placement areas. Since most of the project area is within Mississippi Sound, which is relatively shallow water, much of the underwater noise in the lower frequencies would have no potential to affect marine life, as those lower frequencies would not propagate. However, the portion of noise that is a higher frequency would be heard, and could cause temporary avoidance near operations. As sound propagating through the water column attenuates, the effects would decline logarithmically with distance (NRC, 2003), with the sharpest decline in the first few kilometers from the source. The noise would not occur at levels known to cause injury, temporary or permanent, to marine life. Impacts would not be significant.

There are no areas critical for migration, feeding, or reproduction of marine mammals in the placement or dredging areas. Because of the ability of these species to relocate, it is unlikely that localized sediment removal and placement operations would affect them. No significant impacts would occur.

Borrow Site Option 4

Impacts under Borrow Site Option 4 would be similar to those described above for Ship Island restoration. There are no areas critical for migration, feeding, or reproduction of marine mammals in the dredging areas. Because of the ability of these species to relocate, it is unlikely that localized sediment removal operations would affect them. No significant impacts would occur.

Cat Island Restoration

Potential impacts to marine mammals at the Cat Island restoration site and borrow area would be similar to those described above for the Ship Island restoration.

There are no areas critical for migration, feeding, or reproduction of marine mammals in the placement or dredging areas. Because of the ability of these species to relocate, it is unlikely that localized sediment removal and placement operations would affect them. No significant impacts would occur.

Littoral Placement of Dredged Material

Modification to the placement of dredged material to the combined DA-10/littoral zone area would not result in changes in potential impacts to marine mammals.

5.4.5.2 Other Alternatives Considered

Impacts under Borrow Site Options 1, 2, and 3 would be similar to those described above for Ship Island restoration. No significant impacts to marine mammals would occur.

5.4.5.3 No-Action Alternative

Under the No-Action Alternative, continued loss and degradation of coastal ecotone habitats could negatively affect marine mammal communities that utilize estuarine habitats.

5.4.6 Marine and Coastal Birds

The significance criteria for neotropical, marine, and coastal birds would be a permanent loss or modification of habitat critical for life history requirements of a species or loss of an age cohort of a species of these types of birds; or substantial interference with the movement of native resident or migratory marine and coastal birds.

5.4.6.1 Tentatively Selected Plan

Ship Island Restoration

Marine and coastal birds are common in the area and could utilize the placement sites at Camille Cut and East Ship Island for foraging, nesting, roosting, or stopovers during migration. Nesting birds typically occupy the area between April and August. Monthly surveys have also identified April to October as the period of greatest overall use of the island by birds (Appendix J). Migrants are typically present from mid-April through early May and early September through mid-October (Moore et al., 1990). Resident species are present year-round.

Migratory birds, which use the barrier islands as critical stopover locations, specifically those migrating north, normally arrive in a stressed condition due to low body reserves of fat. Disturbance from sediment placement could cause some migrants to avoid portions of the barrier islands during restoration activities and could cause additional stress. These migrants would likely seek other unaffected nearby areas.

Birds could temporarily be displaced during sediment dredging as well as during island placement of the sand. Locations used for sediment discharge could serve as an attractant to some species of birds due to the increase in potential food supply. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts. Birds would be expected to resume use of these areas following completion of the work.

Work would likely occur during nesting, and appropriate monitoring and surveying would occur as recommended in the Adaptive Management and Long Term Monitoring Plan, which is being developed. Appropriate steps, including implementation of buffers, would be utilized where practical; however, due to logistical constraints, work would have to continue. For example, once the placement of fill in Camille Cut is initiated, the process would have to continue through completion or the fill material would be susceptible to rapid erosion through the original Camille Cut.

Long-term beneficial impacts to birds, including the recently de-listed eastern brown pelican, following restoration would result from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. However, the proposed placements would result in a beneficial impact to migratory birds from the creation of new barrier island habitat, along with associated new forage and nesting areas, and protection of other adjacent barrier island habitats (e.g., interior wetlands, shrub/scrub, and forested habitats). Proposed vegetation plantings on the new dunes in Camille Cut would provide additional food supply for these coastal, marine, and migratory species. In addition, the restored barrier islands would help protect vital bird habitat along the Mississippi coast from the intensity of storm surges and storm waves (Appendix D).

Borrow Site Option 4

Increased turbidity associated with sediment removal at the Cat Island, Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas. In addition, noise associated with removal activities could disrupt birds foraging in the vicinity. However, these birds are not dependent upon the removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and Mississippi Sound, and that plunging and diving birds would likely shift to other nearby areas if temporarily displaced. Following sediment removal and placement, birds would be expected to resume normal use of the area. Any impacts would likely be localized, temporary, and minor, and therefore not significant.

Cat Island Restoration

Marine and coastal birds are common in the area and could utilize the placement sites at Cat Island for foraging, nesting, roosting, or stopovers during migration. Impacts from removal and placement of sediment at Cat Island would be similar to those described for the Ship Island restoration above. These impacts include:

- Foraging, nesting, roosting, and migration stopover habitat would experience significant impacts during restoration. Habitat on and adjacent to restoration areas would be disrupted during mating, nesting, and migration periods. In addition, birds could be disrupted by turbidity plumes, noise, and construction activity.

- Long-term significant beneficial impacts to birds would occur following restoration as a result of improved island stability, enhanced nearshore foraging habitat, and 305 acres of enhanced barrier island habitat. The restored barrier islands would also help protect migratory bird habitat along the Mississippi coast from the intensity of storm surges and storm waves.

Littoral Placement of Dredged Material

Modification to dredged material placement to the combined DA-10/littoral zone area could result in the gradual erosion of Sand Island. Placement of future dredged material primarily to the south and west would not provide sand to replenish Sand Island; however, this change would provide needed sand to the downdrift Horn Island.

5.4.6.2 Other Alternatives Considered

Borrow Site Option 1

Marine and coastal birds could utilize DA-10/Sand Island for foraging, nesting, roosting, or stopovers during migration. Birds could be displaced during sediment dredging and deterred from using areas in the immediate vicinity of equipment during active periods.

Increased turbidity and elevated noise levels associated with sediment removal at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas; however, these birds are not dependent upon the sediment removal and placement sites for survival. Foraging habitat is readily available in the northern Gulf and Mississippi Sound, and plunging and diving birds would likely shift to other nearby areas if temporarily displaced. Following sediment removal and placement, birds would be expected to resume normal use of the area. Any impacts would likely be localized, temporary, and minor, and therefore not significant.

Borrow Site Option 1 would disrupt resident birds and breeding migrants at DA-10/Sand Island. In addition to short-term impacts to nesting, foraging, and roosting behavior in the vicinity of removal activities, approximately 105 acres of habitat for birds would be permanently lost, representing 69 percent of the available island habitat. Species known to nest at DA-10 include least terns, black skimmers, royal terns, sandwich terns, gull-billed terns, willet, American oystercatcher, snowy plover, and Wilson's plover (NPS, 2011). These species would likely experience a permanent decline in population at Sand Island.

However, long-term beneficial impacts to birds following restoration would result from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. Because of this newly created habitat, impacts to birds from the project would be localized, short-term, and minor, and therefore not significant.

Potential impacts to birds are summarized below:

- Foraging, nesting, roosting, and migration stopover habitat on Sand Island in DA-10 would experience significant impacts during restoration. About 105 acres of habitat would be lost and adjacent areas would experience disruptions during mating, nesting, and migration periods.

- Birds could be temporarily disrupted by turbidity plumes, noise, and dredging activity at all borrow areas.

- Long-term beneficial impacts to birds would occur following restoration from the improved island stability, enhanced nearshore foraging habitat, and an increase of 800 acres of barrier island habitat on Ship Island. Because of this newly created habitat, overall impacts to birds from the project would be localized, short-term, and minor (and therefore not significant).

Borrow Site Option 2

Under Borrow Site Option 2, impacts to birds would be similar to those under Borrow Site Option 1 except that increased turbidity associated with sediment removal would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas and could also cause temporary disruptions to birds feeding in those areas. Because of the newly created habitat at Ship Island, impacts to birds would be localized, short-term, and minor, and therefore not significant.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to birds would be similar to those under Borrow Site Option 2 except that the amount of potential nesting habitat lost at DA-10/Sand Island would be less. Approximately 58 acres of habitat for birds would be permanently lost, representing 38 percent of the available island habitat. Nesting species would likely experience a permanent decline in population at Sand Island. However, because of the newly created habitat at Ship Island, impacts to birds would be localized, short-term, and minor, and therefore not significant.

5.4.6.3 No-Action Alternative

Under the No-Action Alternative, barrier islands would continue to degrade and erode and the Mississippi coastal habitats would be at increased risk from storm surges and storm waves. This would reduce the amount and quality of breeding, foraging, and roosting habitat available for migratory, marine, and coastal birds.

5.4.7 Hard Bottom Habitats

The significance criterion for hard bottom habitats would be the permanent loss of hard bottom habitat.

5.4.7.1 Tentatively Selected Plan

No hard bottom habitat is known from the locations associated with the TSP. No impacts would occur.

5.4.7.2 Other Alternatives Considered

No hard bottom habitat is known from the locations associated with any of the borrow site options. No impacts would occur.

5.4.7.3 No-Action Alternative

No change in existing conditions would occur under the No-Action Alternative.

5.4.8 Rare, Threatened, and Endangered Species

5.4.8.1 Tentatively Selected Plan

Ship Island Restoration

Several rare, threatened, or endangered species could occur in the project area, including protected turtle, fish, bird, and mammal species. Marine mammal species are discussed in Section 5.4.5.

Sea Turtles

Protected turtle species potentially occurring in the area include green, Kemp’s ridley, leatherback, hawksbill, and loggerhead sea turtles. Placement activities that could disturb sea turtles include the use of pipelines, barges, anchors, and booster pumps.

Although the islands are not widely used for nesting, at the Camille Cut and East Ship Island placement sites, sea turtle nesting habitat could be affected. In 2012, three loggerhead turtle nests were documented on Cat, West and East Ship Islands, and several additional nests were observed on Horn and Petit Bois Islands. During construction, access would be obtained from the southern and possibly the northern sides of East and West Ship Islands. Land-based equipment and pipelines could temporarily be used on the existing beach. To avoid and minimize potential impacts to nesting sea turtles, daily surveys would be conducted for nests within the construction zone, and the work area would be monitored for potential conflicts with nesting activity throughout the nesting season (April 15 - November 30). If nests are discovered within the work area, the nests would be relocated by appropriate personnel where necessary.

Long-term benefits to potential sea turtle nesting would result from the net increase of 800 acres of new barrier island habitat at Ship Island. No significant long-term impacts to turtle nesting habitat would be anticipated from the sand placement activities.

Noise from placement and dredging activities would not be expected to affect migration, nursing, breeding or feeding/sheltering of these species. The noise levels from construction activities are expected to be below the predicted noise effect thresholds noted by Richardson et al. (1995) and fall within the range of background noises that already exist in the environment. Turtles would be able to move away from the immediate noise sources

Localized temporary impacts would occur during the restoration timeframe from the operation of equipment and vessels in borrow and placement areas. Normal behavior patterns of sea turtles are not likely to be significantly disrupted by the project activities because of the short-term localized nature of the activities and the ability of sea turtles to avoid the immediate area. Additional discussion of these species and potential impacts are included in a BA prepared for the project (Appendix N).

Gulf Sturgeon

The Gulf sturgeon migrates through Mississippi Sound and could occur in the Sound at any time. However, recent monitoring has determined that the species appears in greater numbers around East and West Ship Islands in November and December (Appendix K). Sturgeon are a highly mobile species and would likely avoid placement areas due to noise and project activities. The species tends to concentrate around the barrier islands when in the project area (Ross et al., 2009), so it would likely be displaced from some preferred areas by placement activities. Following the completion of placement activities, displaced animals would be expected to resume use of the general area.

The placement activities would result in a loss of approximately 511 acres of GSCH within the Camille Cut and East Ship placement areas. There would be an overall net loss of 0.08 percent of designated critical habitat for the project area. However, beneficial impacts would occur from the creation of new sheltered foraging habitat north of the newly closed 3.5-mile-wide Camille Cut.

Placement activities could result in bottom disturbance and turbidity that could temporarily affect water quality. Turbidity levels would be monitored during construction to ensure compliance with the state water quality certification. In addition, minor, short-term changes in DO would likely occur during dredging and placement activities. However, no long-term changes in temperature, salinity, pH, hardness, or other chemical characteristics would likely occur. No alteration of critical habitat as a result of changes in water quality would be expected.

Long-term benefits to critical habitat water quality could result from replenishment of barrier islands, which could aid in maintaining the salinity gradient between Mississippi

Sound and the open ocean. The material to be used during the restoration would be predominantly sand-sized particles and would be compatible with adjacent habitats. No change in sediment characteristics would be expected and placement activities would not likely alter critical habitat due to changes in sediment quality. Consequently, no significant impacts to the Gulf sturgeon or their critical habitat would be expected.

Migration of Gulf sturgeon would be permanently altered at Camille Cut, and sturgeon would not be able to move between East and West Ship Islands once the initial berm is established. Consequently, this would be an adverse impact to the Gulf sturgeon and their critical habitat. As mentioned above, the overall net loss is small compared to availability of critical habitat within the entire Mississippi Sound. In addition, placement activities at East Ship Island may temporarily disrupt their movement around the southern shoreline of the island. However, Horn Island Pass to the west and Dog Keys Pass to the east would remain unaffected by the action.

Noise generated from placement and dredging activities would fall within the range of background noises that already exist in the environment. Gulf sturgeon would be able to move away from the immediate noise sources. The noise levels and durations generated by dredge and placement activities would not be expected to affect the migration, nursing/breeding, or feeding/sheltering of this species.

Additional discussion of these species and potential impacts are included in a BA prepared for the project (Appendix N).

Piping Plover and Red Knot

USFWS has designated critical habitat for the wintering piping plover. The project area includes critical habitat for Unit 14. The restoration at Camille Cut and East Ship Island would add approximately 599 acres of usable designated piping plover critical habitat to the existing 139 acres; as a result, there would be 738 acres after the project is completed. This would consist of additional acres of island habitat, including new shoreline and swash zone habitat for the birds to use.

The proposed design for closure of Camille Cut (Figure 5-1) was developed to avoid, to the extent practical, the tips of East and West Ship Islands, which are more heavily utilized by piping plover; however, some portions of the habitat would be temporarily covered during construction activities. In addition, as the land mass of barrier islands and the amount of tidally exposed land increases and becomes colonized by prey items, the amount of potential foraging habitat would increase.

Suitable wintering habitat for the red knot, a candidate species for listing under the ESA, exists on East Ship and West Ship Islands and would be temporarily affected. The impacts to Red knots and their wintering habitat is similar to that described for the piping plovers. Aboveground noise could cause disruptions to piping plover and red knot. Typical noise levels produced by construction operations are in the 80- to 95-dB range (California State Lands Commission [CSLC] et al., 2005). Mechanical dredging produces noise between 58 and 70 dB for a person 50 feet from the operation (USEPA, 2003). The potential noise effects would occur for the duration of construction. Perceptions of construction noise would be attenuated by background sounds from wind and surf.

FIGURE 5-1
CAMILLE CUT AND SHIP ISLAND PLACEMENT AREAS
MsCIP COMPREHENSIVE BARRIER ISLAND RESTORATION SEIS

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Birds could be sensitive to noise from sediment placement and dredging activities. Bird species could be displaced from some potential foraging, nesting, and resting areas by noise from equipment at East Ship Island and West Ship Island. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Any displacement would be limited to the duration of the restoration activities. Birds would be expected to resume use of these areas following completion of the work.

Impacts from aboveground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts.

Borrow Site Option 4

As noted above in the Ship Island restoration discussion, several species could occur in the project area, including protected species. Noise impacts to these species in borrow areas would be similar to those described in the Ship Island discussion.

Protected turtle species potentially occurring in the area include green, Kemp's ridley, leatherback, hawksbill, and loggerhead sea turtles. Project implementation could include the use of hydraulic, hopper, or mechanical dredges, pipelines, barges, anchors, and booster pumps. The NOAA Fisheries Service issued the Gulf Regional Biological Opinion for Dredging of Gulf of Mexico Navigation Channels and Sand Mining Areas Using Hopper Dredges by USACE Galveston, New Orleans, Mobile, and Jacksonville Districts (Gulf of Mexico Regional Biological Opinion [GRBO]) (Consultation Number F/SER/2000/01287) dated November 19, 2003. That document determined that a hydraulic cutterhead dredge was not known to impact Gulf sturgeon or sea turtles. The GRBO also identified conditions to minimize the potential for impacts to protected species when using a hopper dredge. The GRBO was amended in 2005 and 2007. The USACE would comply with the terms and conditions in the GRBO during dredging activities.

Dredging activities would adhere to the reasonable and prudent measures in the NOAA Fisheries Service's 2003 GRBO (amended in 2005 and 2007) to minimize potential adverse impacts to these protected species.

The Gulf sturgeon migrates through Mississippi Sound and could occur in the Sound at any time. The Gulf sturgeon feeds on the bottom and could be captured or entrained by some types of dredging equipment (e.g., hopper dredges). Temporary displacement could result from the disturbance associated with dredging activities at the Ship Island Horn Island Pass, PBP-AL, PBP-MS, and PBP-OCS borrow areas. Gulf sturgeon occur regularly in the project area, but dredging impacts would likely be limited to incidental contact during foraging and subsequent avoidance of active work areas. Sturgeon are a highly mobile species and are likely to avoid the project area due to noise and project activities. Following the completion of dredging activities, any displaced animals would be expected to resume use of the general area. Although it would be unlikely, incidental mortality could result from entrainment by dredging equipment, but would not result in large population reductions. The species tends to concentrate around the barrier islands when in the project area (Ross et al., 2009), so it would likely be displaced from some preferred areas by placement activities.

The GRBO terms and conditions for hopper dredging and relocation trawling limit the incidental take of Gulf sturgeon in the USACE Mobile District to two fish from hopper dredging and eight fish from relocation trawling. Because work would comply with the GRBO, only minor temporary impacts to Gulf sturgeon would be expected and the impacts would not be significant.

The borrow areas in Borrow Site Option 4 do not include any designated critical habitat for the Gulf sturgeon. However, dredging the borrow areas could cause indirect short- and long-term impacts to the Gulf sturgeon outside of designated critical habitat areas due to impacts to benthic invertebrates (part of their food supply). The portions of the borrow areas that would be impacted are small (2,263 acres) relative to the available habitat in and near Mississippi Sound and are located outside of critical habitat. Therefore, this change would be unlikely to alter food supply within critical habitat as a result of reduction of prey items. Any impacts would be negligible. Previous studies have found that benthic communities recover rather quickly from these types of disturbances and suggest that impacts on potential prey species would be short-term (Saloman et al., 1982).

Dredging activities could result in bottom disturbance and turbidity that could affect water quality, but impacts from sediment disturbance during dredging would likely be temporary and minor. Suspended particles would settle quickly and have no measurable effects on water quality. Minor, short-term changes in DO and turbidity would likely occur during dredging activities. However, no long-term changes in temperature, salinity, pH, hardness, or other chemical characteristics would likely occur. During dredging activities, turbidity levels would be monitored to ensure compliance with the state water quality certification. No alteration of critical habitat as a result of changes in water quality would be expected. Migration of individual Gulf sturgeon could be temporarily disrupted by dredging activities within the project footprint. However, Horn Island Pass to the west and Dog Keys Pass to the east would remain unaffected by the action. Consequently, no significant impacts to the Gulf sturgeon or their critical habitat would be expected.

Because upland areas would not be impacted, no impacts to piping plover or red knot habitat would occur.

Cat Island Restoration

Potential impacts to threatened and endangered species from placement activities on Cat Island and dredging of the Cat Island borrow area would be similar to those described for the Ship Island restoration. Protective measures utilized for threatened and endangered species would be identical to those described for the Ship Island restoration. Long-term benefits to potential sea turtle nesting would result from the enhancement of barrier island habitat at Cat Island. No significant long-term impacts to turtle nesting habitat would be anticipated from the sand placement activities.

Temporary displacement could result from the physical and noise disturbances associated with dredging activities at the Cat Island borrow area. Noise impacts would be similar to those described for Ship Island. The GRBO terms and conditions for hopper dredging and relocation trawling would be followed as described above in the Ship Island restoration discussion. Because work would comply with the GRBO, only minor temporary impacts to Gulf sturgeon would be expected and the impacts would not be significant.

Activities associated with placement would cover epibenthic crustaceans and infaunal polychaetes that serve as potential prey items for the Gulf sturgeon. The placement activities would result in a loss of approximately 168 acres of GSCH at Cat Island and would contribute to an overall net loss of designated habitat in Mississippi Sound and near the barrier islands (Appendix N).

Dredging the borrow areas would cause both short- and long-term impacts to the benthic invertebrate food supply for the Gulf sturgeon through a temporary loss of benthic invertebrate populations and disruption of benthic community structure. Approximately 282 acres of benthic habitat associated with the Cat Island borrow area would be affected. Dredging would be unlikely to alter critical habitat as a result of reduction of prey items.

Potential impacts to water quality, sediment quality, and noise would be similar to those described above for the Ship Island restoration. No significant impacts to the Gulf sturgeon or their critical habitat would be expected.

The restoration project would add 162 acres of usable piping plover habitat; as a result, there would be a total of 261 acres of usable habitat once the project is completed and the shoreline has reached equilibrium. Potential habitat for the red knot exists on Cat Island and would be impacted; short-term noise impacts similar to those described for Ship Island could occur. Temporary displacement of red knots and losses and gains to potential habitat would occur during construction, but no significant long-term impacts would be anticipated. During restoration activities, existing swash zone, shoreline, and other upland habitat along Cat Island would be covered. The restoration at Cat Island would result in 305 acres of new enhanced barrier island habitat.

Littoral Placement of Dredged Material

Future placement of suitable sandy material from the Horn Island Pass portion of the Pascagoula Harbor Navigation Channel would be placed farther south and west in the combined DA-10/littoral zone site along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential (Figure 3-16). The area of potential direct placement would encompass 1,600 acres at depths of 5 to 30 feet.

Summary

The overall potential impacts from the TSP to threatened and endangered species are summarized in the BA (Appendix N).

The BA prepared to evaluate impacts from the proposed project on protected species made the following determinations (Appendix N):

- Gulf Sturgeon--may be affected, but not likely to be adversely affected. Continued existence of the species would not likely be jeopardized. The activities associated with this project will not adversely modify designated GSCH.

- Sea turtles (loggerhead, leatherback, green, Kemp's Ridley, and hawksbill)--operations associated with this project may affect, but are not likely to adversely affect and will not jeopardize the continued existence of the species.

- Piping plover--may be affected but not likely to be adversely affected. The activities associated with this project will not adversely modify designated Piping plover critical habitat. Project activities would result in a net gain of usable piping plover habitat.

5.4.8.2 Other Alternatives Considered

Borrow Site Option 1

Impacts to the protected species would be similar to those described in Borrow Site Option 4 with the exception of impacts at Sand Island within DA-10. The DA-10 borrow area is located within piping plover and GSCH.

Based on 2010 shoreline data, 240 acres of DA-10/Sand Island borrow area is within the designated piping plover critical habitat, and 112 of these acres are usable (above MLLW). Use of material from this area would result in a loss of 102 acres of piping plover critical habitat. However, only 10 of the 102 acres are considered usable by piping plovers, with elevations from 4 to 5 ft and tidal flats along the perimeter. This portion that is primarily used by birds is located along the southern shoreline and would not be affected by the project.

Based on 2010 shoreline data, 345 acres of DA-10/Sand Island borrow area is within GSCH, and 258 of these acres are usable (below MHW). There would be beneficial impacts from borrow activities at this borrow area, which would result in the restoration of approximately 106 acres of GSCH to the system.

Potential habitat for the red knot, a candidate species for listing under the ESA, exists on the Mississippi barrier islands and Sand Island within DA-10. Sand Island, within DA-10, would be altered by removal of part of the island to use as a sand source for restoration. A total of 105 acres from the northern part of Sand Island, including nearshore areas, would be lost from sand borrow activities. Temporary displacement of red knots and losses of potential habitat would occur from sediment removal but no significant long-term impacts would be anticipated since additional new habitat would be added on Cat Island and the restored Ship Island.

Borrow Site Option 2

Potential impacts to threatened and endangered species under Borrow Site Option 2 would be similar to those under Borrow Site Option 1 with the following exception: use of the Horn Island Pass and PBP-MS borrow areas could also result in short- and long-term negligible indirect impacts to the benthic invertebrate food supply for the Gulf sturgeon through a temporary loss of benthic invertebrate populations and disruption of benthic community structure at those locations. The total amount of impact to potential foraging areas would be 2,501 acres. As with Borrow Site Option 1, only the aquatic portion of DA-10 is within GSCH. Impacts at that location would be identical to those of Borrow Site Option 1. No significant impacts to Gulf sturgeon foraging habitat would be expected.

Borrow Site Option 3

Potential impacts to threatened and endangered species under Borrow Site Option 3 would be similar to those under Borrow Site Option 2 with the following exceptions:

- Removal of material from all areas would total 2,448 acres. This would result in a proportional reduction in potential impacts to the Gulf sturgeon compared to Borrow Site Option 2. As with Borrow Site Option 2, no significant impacts would be expected to Gulf sturgeon foraging habitat under Borrow Site Option 3.
- Removal of material from a different part of DA-10/Sand Island would result in impacts to 58 acres of Sand Island, compared to 105 acres under Borrow Site Option 2. This

would result in a proportional reduction in potential impacts to the piping plover and red knot compared to Borrow Site Option 2.

5.4.8.3 No-Action Alternative

Under the No-Action Alternative, the barrier islands could continue to erode, resulting in the potential loss and degradation of habitat for protected species, such as wintering habitat for the piping plover, foraging habitat for the Gulf sturgeon, and foraging and nesting habitat for sea turtles.

5.5 Essential Fish Habitat

The significance criterion for the EFH in the project area would be a permanent change in or loss of the habitat designated as critical to fish species of concern in Mississippi Sound.

5.5.1 Tentatively Selected Plan

5.5.1.1 Ship Island Restoration

Placement of sand in Camille Cut and on the southern shoreline of East Ship Island could temporarily reduce the quality of EFH in the vicinity and individuals may be displaced. However, ample habitat is available in the vicinity to accommodate these displaced individuals. As noted above, estuarine emergent wetlands (Section 5.4.1), oyster reefs (Section 5.4.3), and SAV (Section 5.4.1) would not likely be adversely affected. Placement operations would cover benthic organisms; however, as detailed in Section 5.4.3, no significant long-term impacts to this resource would likely occur as a result of the TSP. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of Mississippi Sound), no significant long-term impacts would be expected.

As noted above and notwithstanding the potential harm to some individual organisms, no significant impacts to managed finfish (Section 5.4.4) or shellfish (Section 5.4.3) populations would likely result from sand placement operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during placement activities and would be able to return to the area after activities cease.

Following completion of restoration activities, long-term beneficial impacts to fish and shellfish habitat for breeding and foraging would result from stabilization and enhancement of the shallow water nursery and foraging habitat around the barrier islands and the protection from increasing salinity provided to estuarine waters in Mississippi Sound.

Borrow Site Option 4

Dredging of the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas could temporarily reduce the quality of EFH in the vicinity of Borrow Site Option 4 and individuals may be displaced. However, ample habitat is available in the vicinity to accommodate these displaced individuals. As noted in Section 5.3, increased water column turbidity during dredging would be temporary and localized. Dredging operations would remove or disrupt benthic organisms; however, as discussed in Section 5.4.3, no significant long-term impacts to this resource would likely occur. As noted above and notwithstanding the potential harm to some individual organisms, no significant impacts to finfish (Section 5.4.4) or shellfish (Section 5.4.3) populations would likely result from sand placement operations. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of Mississippi Sound), no significant long-term impacts would be expected. No mitigation would be required for the disruptions to EFH, as the fish would move out of the area during dredging activities and would be able to return to the area after activities cease.

5.5.1.2 Cat Island Restoration

Dredging of the Cat Island borrow area and placement of sand on the eastern shoreface of Cat Island could temporarily reduce the quality of EFH in the vicinity and individuals may be displaced. However, as with the Ship Island restoration discussed above, ample habitat is available in the vicinity to accommodate these displaced individuals. Estuarine emergent wetlands, oyster reefs, and SAV would not likely be adversely affected. Placement operations would cover benthic organisms; however, as discussed in Section 5.4.3, no significant long-term impacts to this resource would likely occur. Increased water column turbidity during dredging would be temporary and localized. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of Mississippi Sound), no significant long-term impacts would be expected.

No significant impacts to managed finfish or shellfish populations would likely result from the borrow area dredging and sand placement operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during placement activities and would be able to return to the area after activities cease.

Following completion of restoration activities, long-term beneficial impacts to fish and shellfish habitat for breeding and foraging would result from stabilization and enhancement of the shallow water nursery and foraging habitat around Cat Island.

5.5.1.3 Littoral Placement of Maintenance Dredged Material

Modification of the placement of dredged material to the combined DA-10/littoral zone site would not result in changes in potential impacts to EFH.

5.5.2 Other Alternatives Considered

Borrow Site Option 1

Dredging of the Ship Island, PBP-AL, and DA-10/Sand Island borrow areas could temporarily reduce the quality of EFH in the vicinity of Borrow Site Option 1 and individuals may be displaced. However, ample habitat is available in the vicinity to accommodate these displaced individuals. Increased water column turbidity during dredging would be temporary and localized. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of Mississippi Sound), no significant long-term impacts would be expected.

Although individual organisms could be impacted, no significant impacts to managed finfish or shellfish populations would likely result from the borrow area dredging operations. No mitigation would be required for the temporary disruptions to EFH, as the fish would move out of the area during dredging activities and would be able to return to the area after activities cease.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that additional short-term impacts to the quality of EFH and displacement of individuals would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Because of the amount of habitat available in Mississippi Sound and along the continental shelf, no significant impacts would be expected. Less material would be dredged from the PBP-AL borrow site compared to Borrow Site Option 1 (3.4 mcy versus 12.2 mcy), which would result in impacts occurring over a shorter duration at that borrow area compared to Borrow Site Option 1.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2, except that more material would be dredged from the PBP-AL borrow site compared to Borrow Site Option 2 (4.8 mcy versus 3.4 mcy), which would result in impacts occurring over a longer duration at that borrow area. No significant impacts to EFH would occur.

5.5.3 No-Action Alternative

The No-Action Alternative could result in continued erosion of the barrier islands and increasing salinity in Mississippi Sound. Permanent loss or degradation of important breeding and foraging habitat could occur.

5.6 Special Aquatic Sites

The significance criterion for special aquatic sites would be any permanent or long-term adverse impact to such a site.

5.6.1 Tentatively Selected Plan

A portion of the TSP is within the GUIS and is therefore considered a special aquatic site. The TSP was developed in compliance with NPS regulations and management policies for the GUIS. Restoration of the barrier islands would enhance protection for sites, such as the Grand Bay NERR and the Grand Bay National Wildlife Refuge in Jackson County, and Hancock County Marshes by reducing the intensity of storm-related tidal surges.

Because of the distance between the locations associated with the TSP and the nearest marine sanctuaries and NEP, implementation of this alternative would not negatively affect any special aquatic sites in the vicinity of the project.

5.6.2 Other Alternatives Considered

Impacts to special aquatic sites from other alternatives considered would be identical to impacts from the TSP.

5.6.3 No-Action Alternative

The No-Action Alternative would not affect any marine sanctuaries in the Gulf of Mexico.

5.7 Cultural Resources

This section describes the potential impacts on cultural resources from the proposed barrier island restoration project. Federal regulations require consideration of how the TSP, in comparison to the No-Action Alternative, might affect cultural resources. These regulations (36 C.F.R. § 800) also require consultation with the SHPO and other interested parties on the potential effects to cultural resources. The PEIS lists the federally recognized tribes associated with southern Mississippi, and USACE, as the federal agency, consulted with those tribes on that document. Additional consultations for the barrier island restoration are currently ongoing.

The ACHP has developed regulations that guide federal agencies on how to assess effects of their undertakings on cultural resources and to mitigate those effects, if necessary. Effects to cultural resources are defined in the following ways:

No Cultural Resources Affected. Either no cultural resources are present, or there is no effect of any kind, neither harmful nor beneficial, on those resources.

No Adverse Effect. There is an effect, but the effect is not harmful to those characteristics that qualify the property for inclusion in the NRHP.

Adverse Effect. There is an effect, and that effect diminishes the qualities of significance that qualify the property for inclusion in the NRHP.

Effects to cultural resources may be direct or indirect. The planned activities are assessed to determine the likely effect of those activities on the cultural resources and on the qualities that make them NRHP-eligible. In the context of this project, the criteria used to evaluate impacts on submerged or marine archaeological resources would be related to potential impacts to the resources from dredging operations.

In accordance with 36 C.F.R. § 800.5, an adverse effect is found when an undertaking may alter, directly or indirectly, any of the characteristics of a historic property that qualify the property for listing in the NRHP in a manner that would diminish the integrity of the property's location, design, setting, materials, workmanship, feeling, or association. Direct effects are generally defined as the physical destruction or modification of all or part of a resource. Indirect effects vary, but are typically characterized as the introduction of audible, visual, and atmospheric elements that alter the qualities that make a property eligible for listing in the NRHP. Indirect effects, in the context of cultural resources, are primarily defined as effects that are not caused by a physical impact on the property. Potential adverse effects on cultural resources include, but are not limited to, the following:

- Physical destruction of or damage to all or part of the property
- Alteration of a property (for example restoration, rehabilitation, or repair that is not consistent with the Secretary of the Interior's standards for the treatment of cultural resources)
- Removal of the property from its historic location
- Change of the character of the property's use or of physical features within the property's setting that contribute to its historic significance
- Introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features

Previously unidentified historic or archaeological resources could be discovered during the dredging or placement activities associated with this project. Prior to construction, USACE, NPS, and SHPO, in accordance with state and federal regulations, would develop a system and acceptable process for unanticipated discoveries during dredging. The stipulations would likely be similar to those presented in the West Ship Island North Shore Restoration EA in August 2010 (USACE, 2010b) as part of the overall MsCIP project.

5.7.1 Tentatively Selected Plan

5.7.1.1 Ship Island Restoration

Known terrestrial sites would be avoided. As a result, there would be no direct impact to Fort Massachusetts on the north shore of West Ship Island, or to the French Warehouse site on the north shore of East Ship Island. Due to the immediate threat to Fort Massachusetts, an early restoration was accomplished in 2011-12 that resulted in the placement of 600,000 cubic yards of sand on the north shore of West Ship Island (USACE, 2011b). The comprehensive barrier island restoration would add a greater land area between these resources and the Gulf waters. This increase in land area, while not eliminating the threat of erosion to the resource, would substantially reduce that threat. Sediments that would be used for restoration are similar to the existing shoreline sand and would be compatible with the historic viewshed of the fort. This would be considered a beneficial effect to this cultural resource and would reduce threats from natural disasters and normal wave action (USACE, 2010b). There would be no adverse effect to Fort Massachusetts or the French Warehouse site from the proposed barrier island restoration project.

At potential placement areas (Camille Cut, East and West Ship Island), remote sensing surveys to identify any potential anomalies have been completed. Following coordination with the NPS, these surveys, will be coordinated with the Mississippi SHPO and Federally recognized Tribes. The outcome of this coordination will be reflected in the final SEIS.

Borrow Site Option 4

At borrow sites associated with Borrow Site Option 4 (Ship Island, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass), remote sensing surveys are currently ongoing to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, NPS, and interested tribal governments will occur and be reflected in the final SEIS. Based on existing information, no adverse effects to significant cultural resources would occur from the borrow activities. However, any newly identified cultural resources will be addressed with appropriate measures identified in consultation with the SHPO.

5.7.1.2 Cat Island Restoration

There are known cultural sites on Cat Island which will be avoided to the extent practicable; however, if they cannot be avoided due to engineering constraints, a path forward will be coordinated with the NPS, the Mississippi SHPO, and Federally recognized Tribes as appropriate. The outcome of this coordination will be reflected in the final SEIS. Based on existing information, no adverse effects to significant cultural resources would occur from sand placement at Cat Island. At borrow sites associated with Cat Island, remote sensing surveys are currently ongoing to identify any potential anomalies. Any newly identified cultural resources will be addressed with appropriate measures identified in consultation with the NPS and the Mississippi SHPO.

5.7.1.3 Littoral Placement of Dredged Material

Modification of the placement location for maintenance dredged material to the combined DA-10/littoral zone site would enhance littoral transport of sand out of the area and to barrier islands located to the west. This material could help nourish those islands and could help protect the cultural resources located there.

5.7.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, no significant impacts would occur. DA-10/Sand Island is an existing dredged material disposal site and would not be excavated below the grade of historical fill. There would be no potential for impacts on cultural resources. At other potential borrow sites (Ship Island and PBP-AL), remote sensing surveys are currently ongoing to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, NPS, and interested tribal governments will occur and be reflected in the final SEIS. Based on existing information, no adverse effects to significant cultural resources from the borrow activities would occur. Any newly identified cultural resources will be addressed with appropriate measures identified in consultation with NPS and the Mississippi SHPO.

Borrow Site Option 2

Under Borrow Site Option 2, no significant impacts would occur. DA-10/Sand Island is an existing dredged material disposal site and would not be excavated below the grade of historical fill. There would be no potential for impacts on cultural resources. At other borrow sites (Ship Island, PBP-AL, PBP-MS, PBP-OCS, and Horn Island Pass), remote sensing surveys are currently ongoing to identify any potential anomalies. Following these surveys, coordination with the Mississippi SHPO, NPS, and interested tribal governments will occur and be reflected in the final SEIS. Based on existing information, no adverse effects to significant cultural resources from the borrow activities would occur. Any newly identified cultural resources will be addressed with appropriate measures identified in consultation with the Mississippi SHPO.

Borrow Site Option 3

Under Borrow Site Option 3, impacts to cultural resources would be identical to those under Borrow Site Option 2.

5.7.3 No-Action Alternative

Fort Massachusetts and the French Warehouse site, over the long-term, are threatened by increased wave action and erosion from both Gulf and Mississippi Sound waters. Part of the warehouse site is covered by maritime forest, which is likely slowing erosion in that area, but it is still susceptible to storm damage and other natural elements. The fort suffered extensive damage from Hurricane Katrina, including to the earthen berm, the interior, domed surfaces, cannon carriages, and individual artifacts associated with the fort. The fort has been damaged by tropical weather over the decades and the continued threat of additional storms, storm surge, and continued erosion indicates that the survival of the fort over the long-term is unlikely under the No-Action Alternative. There would likely be an adverse effect to existing historic and cultural resources from the No-Action Alternative.

5.8 Visual and Aesthetic Resources

The significance criteria for visual and aesthetic resources would be a permanent impairment to the viewshed or permanent loss of aesthetic resources.

5.8.1 Tentatively Selected Plan

5.8.1.1 Ship Island Restoration

Temporary impacts to aesthetics would occur in the immediate vicinity of placement activities during construction. Many people utilize Mississippi Sound and the barrier islands within the project area and would likely be disturbed by the presence of heavy equipment and working vessels during the restoration. However, overall sediment placement activities would be short-term and individual placement activities would be temporary. Impacts would be minor, and therefore not significant.

The barrier island restoration project would likely provide residents and visitors with an overall more aesthetically pleasing view as activities are completed and would result in long-term improvements to visual and aesthetic resources.

Borrow Site Option 4

As with the Ship Island restoration above, impacts to aesthetics would occur in the immediate vicinity of sediment removal activities as a result of the presence of working vessels during sediment removal activities. However, impacts from sediment dredging activities would be temporary and minor, and therefore not significant.

5.8.1.2 Cat Island Restoration

Temporary impacts to aesthetics at the Cat Island placement and borrow areas would be similar to those described for the Ship Island restoration above. Sediment dredging and placement activities would be temporary and impacts would be minor, and therefore not significant.

5.8.1.3 Littoral Placement of Dredged Material

Modification of the placement of dredged material to the combined DA-10/littoral zone site would not result in any change in the existing aesthetic environment in the Horn Island Pass vicinity.

5.8.2 Other Alternatives Considered

Borrow Site Option 1

Temporary impacts to aesthetics similar to those described under the Ship Island restoration would occur in the immediate vicinity of sediment removal activities. Many people utilize Mississippi Sound within the project area and would likely be disturbed by the presence of working vessels during the restoration. However, sediment dredging activities would be temporary and impacts would be minor, and therefore not significant.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that temporary impacts would also occur at the PBP-MS, PBP-OCS, and Horn Island Pass borrow areas.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.8.3 No-Action Alternative

Under the No-Action Alternative, gradual alteration of the visual aesthetic quality of the barrier islands would occur as a result of continuing island erosion, vegetative changes, and island land loss.

5.9 Noise

The significance criteria for noise impacts would be a permanent elevation of above-surface noise levels compared to existing ambient conditions or temporary creation of a high noise level (>85 dB) in the vicinity of sensitive human receptors.

Typically, a noise level considered low is less than 45 dB, a moderate noise level is 45-60 dB, and a high noise level is above 60 dB (CSLC et al., 2005).

5.9.1 Tentatively Selected Plan

5.9.1.1 Ship Island Restoration

Above Surface Noise

Noise in the outside environment associated with restoration activities would be expected to minimally exceed normal ambient noise levels. Surface noise associated with restoration would occur from ship operations, use of machinery and heavy equipment, and sand collection/deposition.

There are limited numbers of sensitive noise receptors within a 1-mile radius of any locations in the Ship Island restoration. These receptors consist of people recreating or working in the vicinity of sediment placement and dredging locations and could be temporarily impacted by elevated noise levels. Typical noise levels produced by construction operations are in the 80- to 95-dB range (CSLC et al., 2005). Mechanical dredging produces noise between 58 and 70 dB for a person 50 feet from the operation (USEPA, 2003). The potential noise effects would occur for the duration of construction. Perceptions of construction noise would be attenuated by background sounds from wind and surf.

Seabirds and shorebirds may be sensitive to noise from sediment placement and dredging activities. Sensitive bird species could occur within the project area. Bird species could be displaced from some potential foraging, nesting, and resting areas by noise from equipment on East Ship Island and West Ship Island. Impacts to breeding and roosting areas, including nest abandonment, could occur during placement activities on and adjacent to East and West Ship Islands. Any displacement would be limited to the duration of the restoration activities. Birds would be expected to resume use of these areas following completion of the work.

Impacts from above-ground noise could disrupt nesting behavior in birds, resulting in temporary to long-term impacts. Activities conducted on or immediately adjacent to barrier islands during the nesting season would be preceded by appropriate shorebird nesting surveys. Appropriate steps, including development of buffer areas around identified nesting sites, would be implemented where practical to reduce impacts. Noise impacts to birds are further discussed in Section 5.4.6. Impacts to piping plover and red knot are discussed in Section 5.4.8.

Underwater Noise

Underwater noise would occur in association with placement and dredging activities as described in the Sand Island discussion of noise with regard to fish above.

The primary species of concern for underwater noise impacts during construction are marine mammals, turtles, and finfish. Underwater noises could trigger avoidance reactions in those marine species. However, noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Potential noise impacts to these species are discussed in the following sections:

- 5.4.4 Marine Mammals
- 5.4.7 Sea Turtles
- 5.4.3 Finfish
- 5.4.7 Gulf Sturgeon

Because noise impacts would be limited to the duration of construction and would occur only in restoration areas, no significant noise impacts would occur.

5.9.1.2 Borrow Site Option 4

Under Borrow Site Option 4, noise associated with sand removal would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Noise levels would not occur near any sensitive receptors. Therefore, impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise impacts under Borrow Site Option 4 would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur.

Because noise impacts would be temporary--limited to the duration of dredging activities--and would not occur at levels that would cause injury, no significant noise impacts would occur.

5.9.1.3 Cat Island Restoration

Impacts at the Cat Island placement and borrow areas would be similar to those described under the Ship Island restoration above. Noise receptors within a 1-mile radius of any locations associated with restoration include vacation homes on Cat Island, which would be temporarily impacted by elevated noise levels. In addition, receptors include people recreating or working in the vicinity of the Cat Island sediment borrow area. These receptors would experience temporary to long-term impacts, but impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Impacts from above-ground noise including, human presence, equipment and dredging and placement of dredged material activities, could disrupt nesting behavior in birds, resulting in temporary to long-term impacts.

Because noise impacts would be limited to the duration of construction and would occur only in restoration areas, no significant noise impacts would occur.

5.9.1.4 Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/ littoral zone site would not result in any change in the existing noise environment of the area.

5.9.2 Other Alternatives Considered

5.9.2.1 Borrow Site Option 1

Under Borrow Site Option 1, noise impacts could occur as described above under the Ship Island restoration discussion. Noise levels would not be elevated near any above-surface sensitive receptors. Therefore, impacts would not be significant.

Impacts to bird and marine species are described under the individual discussions for those species (see Ship Island restoration discussion above for references to section numbers). Noise impacts would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Noise would not occur at levels known to cause injury, temporary or permanent, to marine life and significant impacts would not occur. Impacts from above-ground noise at DA-10/Sand Island could disrupt nesting behavior in birds, resulting in temporary to long-term impacts.

Because noise impacts would be temporary--limited to the duration of dredging activities--and would not occur at levels that would cause injury, no significant noise impacts would occur.

5.9.2.2 Borrow Site Option 2

Noise impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1. However, noise impacts could also occur at the Horn Island Pass, PBP-MS and PBP-OCS borrow areas. As with Borrow Site Option 1, the noise under Borrow Site Option 2 at these additional locations would not occur at levels known to cause injury, temporary or permanent, to marine life and would not be elevated near any above-surface sensitive receptors.

5.9.2.3 Borrow Site Option 3

Noise impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2. However, dredging would occur over a shorter duration and result in decreased disruptions of breeding birds at borrow area DA-10/Sand Island, reflecting the time it would take to remove the sand due to the smaller size of that site under Borrow Site Option 3.

5.9.3 No-Action Alternative

The No-Action Alternative would cause no new or increased noise conditions. Therefore, no noise-related impacts would occur.

5.10 Air Quality

The significance criterion for air quality impacts would be an exceedance of a chronic or acute state air quality standard. The coastal counties of Mississippi are currently in attainment for all NAAQS.

5.10.1 Tentatively Selected Plan

5.10.1.1 Ship Island Restoration

Air emissions associated with sediment removal and placement operations would likely be minor. Sediment removal and placement would be conducted using dredging equipment. The USACE Mobile District has historically dredged the navigation channels for Gulfport, Biloxi, and Pascagoula Harbors, including several improvement projects, without violating an air emission standard. In addition, detailed air quality analyses have been performed for dredging locations in nonattainment areas in San Diego, California and Texas City, Texas. Analysis of those operations determined that they would not cause significant air quality impacts (USACE, 2002; USACE, 2007b). Similar equipment and methods would be used for restoration activities, and any air quality impacts would not be significant.

Appropriate technologies would be used to minimize air emissions in the project area, including the use of electric equipment, low sulfur diesel fuel in equipment (such as dredges, tugs, and other diesel-powered equipment), fuel additives, and particulate filters.

Borrow Site Option 4

Under Borrow Site Option 4, potential air quality impacts would occur as described above under the Ship Island restoration discussion. In addition to placement locations at East Ship Island, West Ship Island, and Camille Cut, air impacts would occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. Air emissions would not occur at significant levels.

5.10.1.2 Cat Island Restoration

Impacts at the Cat Island placement and borrow areas would be similar to those described under the Ship Island restoration above. These impacts would not be significant.

5.10.1.3 Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/littoral zone site would not result in any change in the existing air quality in the area.

5.10.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, air quality impacts could occur as described above under the Ship Island restoration discussion. In addition to placement locations at East Ship Island, West Ship Island, and Camille Cut, air impacts would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Air emissions would not occur at significant levels.

Borrow Site Option 2

Impacts to air quality under Borrow Site Option 2 would be similar to those for Borrow Site Option 1. However, emissions would occur over a longer duration due to increased travel and operation time associated with dredging at additional borrow areas (Horn Island Pass, PBP-MS and PBP-OCS).

Borrow Site Option 3

Impacts to air quality under Borrow Site Option 3 would be similar to those for Borrow Site Option 2.

5.10.3 No-Action Alternative

Under the No-Action Alternative, no impacts to air quality would occur.

5.11 Recreation

A permanent disruption, limitation, or alteration of recreation potential would be considered a significant impact.

5.11.1 Tentatively Selected Plan

5.11.1.1 Ship Island Restoration

During placement activities, recreational activities such as sunbathing, nature viewing, boating, sailing, and fishing along the barrier islands may be temporarily disrupted, limited, or altered. Potential temporary impacts may include noise, visual intrusion, and turbidity. Minor impacts for the lifetime of the restoration project would include the loss of fishing areas in Camille Cut between East Ship and West Ship Islands and the loss of Camille Cut as an access point to the Gulf of Mexico.

There would be a significant long-term benefit to recreation on Ship Island from the TSP. The TSP would provide storm damage reduction to two historic sites on East and West Ship Islands and increase the amount of land available for shore fishing, wildlife observation, hiking, and similar recreational activities. Filling of Camille Cut, however, would reduce the area available for recreational boat fishing. In addition, the placement of sand as proposed would help protect the ecological integrity of the Mississippi Sound estuary, resulting in significant benefit to the recreational sector, as described in Section 5.11.

5.11.1.2 Borrow Site Option 4

Under Borrow Site Option 4, temporary impacts to recreational boating and fishing could occur at the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. These impacts could include temporary nuisance noise and visual intrusion from the presence of dredging equipment and would not be significant.

5.11.1.3 Cat Island Restoration

Minor (and therefore not significant) impacts to recreation associated with the restoration of Cat Island would be similar to those described under the Ship Island restoration above. During the borrow and placement activities, recreational activities such as sunbathing, nature viewing, boating, sailing, and fishing along the barrier islands could be temporarily disrupted, limited, or altered.

Restoration of Cat Island would enhance the amount of land available for fishing, wildlife observation, hiking, and similar recreational activities. In addition, the placement of sand as proposed would help protect the ecological integrity of the Mississippi Sound estuary, resulting in significant benefit to the recreational sector, as described in Section 5.11.

5.11.1.4 Littoral Placement of Dredged Material

Modification of the continuing operations at the combined DA-10 and littoral zone site could result in a change to the existing recreational environment at Sand Island since dredged material would not be utilized to replenish the island as has been done in the past.

5.11.2 Other Alternatives Considered

5.11.2.1 Borrow Site Option 1

Under Borrow Site Option 1, temporary minor, and therefore not significant, impacts to recreational boating and fishing could occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. These impacts could include nuisance noise and visual intrusion. Removing portions of the subaerial Sand Island, within DA-10, could impact recreational activities such as sunbathing and hiking.

5.11.2.2 Borrow Site Option 2

Impacts to restoration under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that temporary minor impacts to recreational boating and fishing could occur at the additional borrow areas associated with Borrow Site Option 2 (Horn Island Pass, PBP-MS, and PBP-OCS). These impacts could include nuisance noise and visual intrusion, but would not be significant.

5.11.2.3 Borrow Site Option 3

Impacts to restoration under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.11.3 No-Action Alternative

Continued erosion and loss of the Mississippi barrier islands within GUIS could result in significant adverse consequences not only to the natural and cultural resources managed by NPS and used for recreation, but also to the overall health of the Mississippi Sound ecosystem and mainland coastal communities. Under the No-Action Alternative, barrier island land loss would continue to increase. Significant resources managed by NPS, including Fort Massachusetts, could be lost. The MsCIP PEIS economics study estimated that the average annual value of recreation lost under the No-Action Alternative would be $466,341 (USACE, 2009a).

5.12 Socioeconomic Resources

Socioeconomic impacts would be significant if the TSP were to result in a direct or indirect effect upon demographics, economics, land or water use, utilities, public safety, or coastal infrastructure and ports in the project area or within the region. Significance criteria are discussed by resource area below.

5.12.1 Demographics

Demographic impacts would be significant if the selected alternative were to result in a substantial effect upon demographics in the project area or within the ROI.

5.12.1.1 Tentatively Selected Plan

Given the distance of the offshore borrow and placement areas from populated areas, construction activities associated with the TSP would not have an impact upon demographics within the ROI.

With implementation of this alternative, there could be a beneficial effect upon population and housing as a result of the Barrier Island Restoration project. In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in reduced impact to not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem (USACE, 2009a).

5.12.1.2 Other Alternatives Considered

Impacts to demographics from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.1.3 No-Action Alternative

Under the No-Action Alternative, measures to restore the barrier islands would not be taken and the barrier islands would continue to experience erosion and loss of land mass.

The barrier islands are the first line of defense for the mainland as tropical storms, hurricanes, and dominant southeast winds pass through the region. After Hurricane Katrina, the total population within the ROI decreased. Given the likelihood of another direct hit from a hurricane, the No-Action Alternative could increase the potential for wave damage and storm surge along the coast, affecting demographics along the coast (similar to Hurricane Katrina). Modeling has shown that wave height is reduced as much as several feet by the presence of the islands. Loss of the barrier islands would leave a portion of the densely populated shoreline subject to larger sea waves (USACE, 2009a).

5.12.2 Economics

Economic impacts are would be significant if implementation of the alternative were to result in a substantial effect upon employment, income, or housing in the project area or within the region.

5.12.2.1 Tentatively Selected Plan

Construction activities associated with the TSP could temporarily increase local commerce by employing local residents and increasing traffic and activity around the project area. This increased activity would likely benefit businesses in the region. No accelerated residential or commercial development would likely occur.

The TSP would likely preserve or possibly enhance property values in the project area. In the event of a tropical storm or hurricane, restoration of the Mississippi barrier islands could result in protection of not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem. Increased confidence in the barrier islands providing storm surge risk reduction to the area would have a positive effect on property values, and thus tax revenues, in the vicinity (USACE, 2009a).

The MsCIP PEIS economic impact forecasting system (EIFS) model estimated that the restoration of the islands would result in an increase of $798,984,000 in sales volume, an increase of $167,849,530 in local income, and an increase of 4,920 new jobs (USACE, 2009a). The EIFS model outputs are based on a 5-year (60-month) construction duration and a 50-year period of analysis.

The cost that would be associated with implementation of the TSP has been estimated at $368 million.

5.12.2.2 Other Alternatives Considered

Economic impacts to demographics from implementation of Borrow Site Options 1, 2, or 3 would be similar to those of the TSP, but would have different estimated costs.

Estimated rough order of magnitude costs are:

- Borrow Site Option 1 = $402 million
- Borrow Site Option 2 = $330 million
- Borrow Site Option 3 = $341 million

5.12.2.3 No-Action Alternative

Under the No-Action Alternative, the economy within the ROI would not receive any benefits associated with construction activities.

The restoration of the barrier islands described in this SEIS is an integral part of the MsCIP Comprehensive Plan, as it would enhance the barrier islands and the first line of defense to provide coastal storm damage risk reduction. Taking no action on the barrier islands would result in a significant gap in the MsCIP Comprehensive Plan, and without the TSP the long-term economic benefits associated with the storm surge damage risk reduction would not be fully realized.

5.12.3 Commercial and Recreational Fishing

The significance criteria for commercial and recreational fishing in the project area would be an effect to the species or a change to the habitat structure that would lead to a change in species composition or long-term changes in revenue for fisheries in Mississippi Sound. It should be noted that only recreational fishing is allowed within the GUIS boundaries.

5.12.3.1 Tentatively Selected Plan

Ship Island Restoration

Sediment removal and placement would temporarily disrupt fish distribution and localized commercial and recreational fishing in the immediate vicinity of East Ship and West Ship Islands. However, once operations were completed, the fish community would return to the area and fishing activities would return to previous conditions. In addition, during the operations, fishing activities could be conducted at other locations in Mississippi Sound. Any negative impacts to fisheries from restoration activities would not be significant.

Long-term beneficial impacts to fish habitat would occur from stabilization and enhancement of the shallow water nursery and foraging habitat around the barrier islands. The MsCIP PEIS estimated that over $43 million in fishery losses could be avoided by the restoration of Ship Island and the closure of Camille Cut (USACE, 2009a). The restoration of Ship Island would help limit saltwater intrusion into Mississippi Sound, as well as helping protect and maintain critical habitat for a variety of estuarine-dependent species (e.g. the Eastern oyster, shrimp, blue crab, and speckled trout).

Borrow Site Option 4

Sediment removal would temporarily disrupt fish distribution and localized commercial and recreational fishing in the Ship Island, PBP-AL, Horn Island Pass, PBP-MS, and PBP-OCS borrow areas. However, once operations were completed, the fish community would return to the area and commercial and recreational fishing activities would return to previous conditions. In addition, during the operations, fishing activities could be conducted at other locations in Mississippi Sound. Therefore, impacts to commercial and recreational fisheries from restoration activities would not be significant.

Cat Island Restoration

Impacts to commercial and recreational fishing associated with the restoration of Cat Island would be similar to those described under the Ship Island restoration above.

Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material to the combined DA-10/ littoral zone site would not result in any significant change to recreational fishing at the site.

5.12.3.2 Other Alternatives Considered

Borrow Site Option 1

Under Borrow Site Option 1, temporary impacts to commercial and recreational and fishing would occur at the Ship Island, DA-10/Sand Island, and PBP-AL borrow areas. Impacts would be similar to those described under Borrow Site Option 4 and would not be significant.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be similar to those under Borrow Site Option 1, except that non-significant disruptions to fish and fishing opportunities would also occur at the Horn Island Pass, PBP-MS, and PBP-OCS borrow areas.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be similar to those under Borrow Site Option 2.

5.12.3.3 No-Action Alternative

Under the No-Action Alternative, continued loss and alteration of coastal ecotone habitat and increasing salinity in Mississippi Sound could negatively impact important commercial and recreational fisheries.

5.12.4 Land and Water Use

Land and water use impacts would be significant if the selected alternative were to do one or more of the following:

- Substantially conflict with established land and water uses in the area
- Be incompatible with surrounding land uses
- Substantially conflict with applicable land and water use goals, objectives, policies, guidelines, or adopted environmental plans

Applicable land and water use goals, objectives, and policies applicable to the project area are summarized in Section 4.13.4 and include the 1964 Wilderness Act, the NPS Organic Act, and NPS *Management Policies* (2006).

5.12.4.1 Tentatively Selected Plan

The TSP would be carried out in a manner that is consistent with NPS's purposes (16 U.S.C. § 459h-5). NPS, in collaboration with other agencies (USACE, USGS, NOAA Fisheries Service, USEPA, NOAA, USFWS, and MDMR), has concluded that long-term restoration of the sediment transport system and budget is crucial for preserving and protecting the Mississippi barrier islands' natural and cultural resources (USACE, 2009a). This Mississippi barrier island restoration represents the results of extensive interagency consultation and collaboration and would not have a significant impact on land resources. Details on specific components of the TSP, as they relate to land and water resources, are provided below.

Ship Island Restoration

Restoration of Ship Island would not introduce new or different land uses, and it would support the NPS goal of preserving and protecting the natural processes affecting the barrier islands. Significant storm events and a reduction in sand supply contributed to substantial land area losses between 1847 and 2005, ranging from 24 percent at Horn Island to 64 percent at East and West Ship Islands. Petit Bois Island, which is located east (updrift) of Horn Island Pass, experienced a 56 percent reduction in land area between 1847 and 2005 (USACE, 2009a).

Borrow Site Option 4

Borrow Site Option 4 would not introduce new or different land uses and it would not affect any existing land use plans or policies. As a result, there are no impacts on land or water use from Borrow Site Option 4.

Cat Island Restoration

Restoration of Cat Island would not introduce new or different land uses. The restoration of Cat Island is intended to preserve and protect the natural processes affecting the barrier islands and protect them from further land losses. The restoration would have no adverse impacts on land use and would not conflict with any other land use policy or goal.

Littoral Placement of Maintenance Dredged Material

Modification to the placement of dredged material at the combined DA-10/littoral zone site would not introduce new or different land uses. Material currently being placed on Sand Island, within DA-10, would be placed into the littoral system, to preserve and protect the natural processes affecting the barrier islands. The placement of material in the new location would not conflict with any land use policy or goal and would have no adverse impacts on land use.

5.12.4.2 Other Alternatives Considered

Under Borrow Site Options 1, 2, and 3, conflicts with land and water use would occur. These borrow options include the use of the DA-10/Sand Island borrow area, which includes the subaerial feature, Sand Island. This borrow area is within the boundary of the GUIS.

Borrow Site Option 1

Under Borrow Site Option 1, 5.1 mcy of sand would be borrowed from DA-10/Sand Island, which is protected under the NPS *Management Policies* related to use of borrow areas on NPS lands. Utilizing material from DA-10, and specifically from Sand Island within DA-10, would be considered an impairment of NPS resources, which is prohibited under NPS policy. The use of borrow material from Ship Island and PBP would not affect existing land use plans or policies.

Borrow Site Option 2

Impacts under Borrow Site Option 2 would be the same as those under Borrow Site Option 1. The use of borrow material from Horn Island Pass would not affect existing land use plans or policies.

Borrow Site Option 3

Impacts under Borrow Site Option 3 would be the same as those under Borrow Site Options 1 and 2.

5.12.4.3 No-Action Alternative

The loss of land mass on the barrier islands has been documented, and the continued loss would result in a change in the ecology of Mississippi Sound (USACE, 2009a).

Continued erosion and loss of the Mississippi barrier islands could result in significant adverse consequences not only to the natural and cultural resources managed by NPS, but also to the overall health of the Mississippi Sound ecosystem and mainland coastal communities (USACE, 2009a). Under the No-Action Alternative, barrier island land loss would continue to increase. Significant natural and cultural resources managed by NPS, including Fort Massachusetts, could either be lost as a result of erosion or substantial measures could be required for their preservation.

Other existing land and water uses within the ROI could also be compromised under the No-Action Alternative.

5.12.5 Utilities

Utility impacts would be significant if the TSP were to result in the interruption of local or regional utility services so as to pose a substantial inconvenience to the affected population.

5.12.5.1 Tentatively Selected Plan

The TSP would not directly impact utility services in the area. No utility lines are known to be located within any potential borrow or placement areas; therefore, no known utility lines would be significantly impacted or relocated.

Unknown abandoned lines could be present and could be disturbed. If utility lines are discovered during dredging, the appropriate permits would be obtained before utilities are relocated. No significant impacts would be expected.

In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in some protection of the existing utility infrastructure associated with the mainland coastal communities (USACE, 2009a).

5.12.5.2 Other Alternatives Considered

Impacts to utilities from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.5.3 No-Action Alternative

Under the No-Action Alternative, the barrier islands would not be restored. Therefore, in the event of a major tropical storm or hurricane, the lack of storm damage reduction provided by the barrier islands could result in the interruption of local or regional utility services so as to pose a substantial inconvenience to the affected population.

5.12.6 Oil and Gas Utilities

Impacts to oil and gas utilities would be significant if the TSP were to result in the interruption of pipeline services that causes a substantial inconvenience to offshore resource extraction.

5.12.6.1 Tentatively Selected Plan

Ship Island Restoration

Placement activities at Camille Cut and East Ship Island would not occur near any oil and gas utilities and therefore would have no impacts.

Borrow Site Option 4

Borrow Site Option 4 has been designed such that it would not directly impact oil and gas pipelines in the area. The only known pipelines in the area that could be affected are near the PBP-MS, PBP-AL, and PBP--OCS borrow areas. At the PBP-AL site, the east borrow locations would be prioritized to reduce the need to work near the pipelines. An approximately 1,000-foot buffer based on modeling would be established on both sides of the pipeline corridors to further avoid potential impacts.

Cat Island Restoration

Placement and dredging activities at Cat Island and Cat Island borrow area are not located near any oil and gas utilities and would not result in any impacts.

Littoral Placement of Dredged Material

Modification to the placement of navigation dredged material into the combined DA-10/littoral zone site would not result in any impacts to oil and gas utilities.

5.12.6.2 Other Alternatives Considered

Impacts to oil and gas utilities from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.6.3 No-Action Alternative

Under the No-Action Alternative, no impacts to oil and gas utilities would occur.

5.12.7 Public Safety

Public safety impacts would be significant if the TSP were to do one or more of the following:

- Cause response times for fire or law enforcement to increase beyond acceptable levels.
- Interfere with emergency response plans or emergency evacuation plans.
- Create a potential public health risk or involve the use, production, or disposal of materials that pose a safety hazard to people in the affected area.

5.12.7.1 Tentatively Selected Plan

Under the TSP, the barrier islands would be restored via dredging in the borrow areas, followed by the transport of sand to the placement areas. To reduce potential public safety impacts and conflicts with dredging equipment, warning buoys would be placed a safe distance from the work area to provide notice to vessel traffic and boaters, and all vessels would be equipped with markings and lights in accordance with USCG regulations. The dredging contractors would participate in an orientation session with the USCG to address safety operating procedures and protocol, and ensure coordination with marine traffic in the area. In addition, a Notification to Mariners would be included in the USCG's weekly publication. The dredging contractor would also participate in a safety orientation with USACE and would be required to keep the public informed of dredging activities. Signs and fencing would be used to deter the public (including children) from entering the work zone. No significant impacts to emergency responders for recreational boaters would likely occur.

Long-term benefits to public safety from restoration of the barrier islands and littoral placement of future dredged material would occur. The restoration would help reduce the intensity of storm waves and storm surges along the Mississippi Coast (Appendix D).

5.12.7.2 Other Alternatives Considered

Impacts to public safety from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.7.3 No-Action Alternative

Under the No-Action Alternative, existing public safety services would not change.

Taking no action on the barrier islands would result in a significant gap in the MsCIP Comprehensive Plan, and without the TSP the long-term public safety benefits associated with the storm surge risk reduction would not be fully realized.

5.12.8 Coastal Infrastructure/Ports

The significance criterion for coastal infrastructure/ports would be a significant change to the current coastal infrastructure and shipping operations at any commercial port in the ROI.

5.12.8.1 Tentatively Selected Plan

Construction activities associated with the TSP would not directly impact any coastal infrastructure or ports.

Modification to the placement of navigation dredged material at the combined DA-10/ littoral zone site would result in the placement of material within an area of high wave-induced currents, which would transport sediments downdrift within the littoral system. Thus, Sand Island's current footprint would be altered by the lack of future dredged material on the island. The change in dredged material placement practices and the resulting reduction in the size of Sand Island are expected over time to reduce constricted flows through the pass that have increased scour in and near the navigation channel between Sand and Petit Bois Islands.

Under average conditions, impacts to the Gulfport Navigation Channel would likely be minor based on sediment transport and morphologic model simulations. However, minor indirect impacts to the Gulfport Navigation Channel could occur from increased transport of sand into the channel during hurricane events. The amount of material moved under such conditions could result in an increase of up to 4 percent to 6 percent over historic dredging volumes (Appendix C). However, no expected increase in maintenance dredging frequency would be anticipated and, therefore, impacts would not be significant.

In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could indirectly result in reduced risk of damage of not only the mainland coastal infrastructure and ports, but also the overall health of the Mississippi Sound ecosystem. The loss of Ship Island would leave a portion of the heavily developed Harrison County shoreline, including the Port of Gulfport, subject to larger sea waves (USACE, 2009a). In addition, modeling has indicated that over a wide range of storms, some storm surge risk reduction would be provided to the eastern coast of Mississippi along the Jackson County shoreline if the barrier islands were restored as proposed (USACE, 2009a).

5.12.8.2 Other Alternatives Considered

Impacts to coastal infrastructure and ports from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.12.8.3 No-Action Alternative

Under the No-Action Alternative, no efforts to restore the existing barrier islands would be undertaken. Therefore, coastal infrastructure and ports within the ROI would not realize the long-term benefits associated with the enhanced storm damage risk reduction. In the event of a major tropical storm or hurricane, the lack of enhanced storm damage risk reduction could result in impacts to coastal infrastructure and the interruption of shipping operations.

5.13 Environmental Justice and Protection of Children

A disproportionate environmental health and safety risk to children, minority, or low-income populations would be a significant impact.

5.13.1 Tentatively Selected Plan

Due to their location of the borrow areas and the undeveloped nature of the barrier islands, construction activities associated with the TSP would not adversely affect or disproportionately impact minority populations, health and safety of children, or low-income populations.

Contractors are required to take are appropriate safety measures.

Implementation of this alternative could have a beneficial effect on population and housing on the mainland. The presence of the islands reduces wave height as much as several feet (USACE, 2009a). In the event of a major tropical storm or hurricane, restoration of the Mississippi barrier islands could result in some reduced risk of not only the mainland coastal communities, but also the overall health of the Mississippi Sound ecosystem (Appendix D).

5.13.2 Other Alternatives Considered

Impacts to minority populations, children, or low-income populations from implementation of Borrow Site Options 1, 2, or 3 would be identical to those of the TSP.

5.13.3 No-Action Alternative

Under the No-Action Alternative, measures to restore the barrier islands would not be taken. No disproportionate impacts would occur to minority populations, children under the age of 17, or families below the poverty level in the ROI.

The barrier islands are the first line of defense for the mainland during tropical storms, hurricanes, and dominant southeast winds that pass through the region. After Hurricane Katrina, the total population within the ROI decreased. Given the likelihood of another direct hit from a hurricane, the No-Action Alternative could increase the potential for wave damage and storm surge along the coast, affecting minorities, children, and low-income families along the coast (similar to Hurricane Katrina). Loss of the barrier islands would leave the densely populated shoreline subject to larger sea waves (USACE, 2009a).

5.14 Cumulative Impacts

Federal regulations implementing NEPA (40 C.F.R. § 1500–1508) require that the cumulative impacts be assessed. NEPA defines a cumulative impact as an impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions (40 C.F.R. § 1508.7). Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time. This analysis considers the impacts of the TSP in conjunction with other projects in Mississippi Sound, the northern Gulf of Mexico, and along the Mississippi Gulf coast.

The following discussion addresses the potential for cumulative impacts resulting from interaction of the TSP and other restoration alternatives considered with other past, present, and reasonably foreseeable actions occurring since Hurricane Katrina. This powerful storm altered the barrier islands, coastal Mississippi, and the floor of the Gulf of Mexico. In conjunction with other major hurricanes (Ivan, Dennis, and Rita) in 2004 and 2005, residual effects from earlier projects would have little potential for interaction with the TSP.

Within coastal Mississippi, recovery work to clean up and rebuild following the landfall of Hurricane Katrina in August 2005 would continue. Because all of this work would occur onshore, there would be limited potential for interaction with the TSP or other restoration alternatives, confined primarily to socioeconomic resources.

Mitigation and restoration activities associated with the April 20, 2010 Deepwater Horizon spill are ongoing. Current projects include an oyster clutch restoration and artificial reef installation in the western part of Mississippi Sound (NOAA, 2013). Additional projects are likely to be developed as further restoration funds become available through natural resource damage assessment settlements, RESTORE Act funding (Clean Water Act fines), and criminal penalties.

Construction is planned by the USACE to improve the Pascagoula Harbor - Bar Channel from 450 feet wide to its federally authorized project dimension of 550 feet wide. Plans are also underway to widen the Bayou Casotte Channel an additional 100 foot to the west beyond its 350 foot wide federally authorized project dimension. The construction of the improvement project will be funded 100 percent by the non-Federal sponsor, Jackson County Port Authority. The USACE is conducting a Feasibility Study of the Bayou Casotte Harbor Channel Improvement Project in accordance under authority of Section 204 of the Water Resources Development Act of 1986 (PL 99-662; 33 U.S.C. 2232, as amended). Should the Section 204 study conclude, then the future operation and maintenance would be undertaken by the USACE as part of its routine maintenance efforts. The Mississippi State Port Authority has plans to upgrade the Port of Gulfport.

The Federal navigation channels were excluded from GSCH (68 Fed. Reg. 53). Portions of the navigation channels extend between the barrier islands and work could occur at the same time, resulting in temporary cumulative impacts to recreation activities, water quality, and biological resources in those areas. A modeling assessment to look at the combined effects of implementing the TSP, widening the Gulfport and Pascagoula Federal Navigation channels to their federally authorized dimensions and closure of Katrina Cut on water quality conditions in Mississippi Sound were conducted (Appendix D). Maximum and minimum changes in DO were well above state standards with the largest drop of 5.52 percent (7.75 to 7.3 mg/L) occurring near Gulfport. Chlorophyll *a* concentrations for all scenarios showed maximum increases of 40 to 50 percent over Pre Katrina conditions near Gulfport and south of Biloxi Bay. With increased chlorophyll *a,* more photosynthesis produced additional DO resulting in the increased DO values during those periods of the simulation. Maximum and minimum percent change of salinity values for the Cumulative scenario showed the largest maximum south of Bay St. Louis and the minimum near Gulfport. However, the changes in salinity at the three nearshore observation sites were within the variability of salinity values occurring during the simulation period for Pre-Katrina conditions. Although results from the analysis demonstrated that the cumulative scenario showed the most deviation from Pre-Katrina conditions, the observed water quality changes were within the state standard for constituents of interest for ocean's waters (Appendix D).

Future maintenance dredging associated with the Pascagoula Harbor Upper Sound Channel segment will be used for the creation of a 425-acre wetland adjacent to Singing River Island. This project, combined with the proposed barrier island restoration and modification of the placement plan for material dredged from the Horn Island Pass Channel segment, could result in a cumulative benefit to littoral, wetland, and island habitats in Mississippi Sound and the northern Gulf of Mexico.

Following the devastation incurred by Hurricane Katrina, the USACE restored the 28-mile long Mississippi Harrison County Hurricane and Storm Damage Reduction project. An additional project feature, dunes and dune plantings, was later constructed on that project as part of an MsCIP Interim project. Over the last four years, an additional 14 MsCIP interim projects have been or are under construction along the three coastal counties of Mississippi.

As part of the first phase of the barrier island restoration effort, the placement of sand along the northern shore of West Ship Island, was recently completed (USACE, 2011b). The project entailed placement of sand along approximately 10,350 feet of shoreline to a width of 150 to 550 feet to help protect the shoreline around Fort Massachusetts. This project could result in cumulative short-term adverse effects to biological resources in the area from repeated disturbances associated with dredging and placement activities. Beneficial long-term cumulative impacts to biological and recreational resources on and near Ship Island would result upon completion of both projects.

Future projects in coastal Mississippi are planned as part of the Mississippi Beneficial Use Group to beneficially utilize material from maintenance and new work dredging of segment(s) of navigation channel(s) and approved upland site(s) to create beaches and emergent tidal marsh habitats. These projects could occur close to or during the same timeframe as the proposed barrier island restoration. No significant adverse cumulative impacts would likely result.

Global climate change is predicted to result in sea level rise and more intense storm activity. The rate of barrier island loss could increase in the future as a result of global climate change (Morton, 2008). Under the No-Action Alternative, processes would continue to allow Ship Island to be vulnerable to storm damage, and existing water quality regime would be maintained in Mississippi Sound. Under the TSP and other restoration alternatives, the sand added to the existing sediment budget of the barrier islands and the change in the use of the existing DA-10/Sand Island disposal area for placement of future dredged material would result in a healthier state for the islands, thus making them more resilient to global climate change. Since one goal of the restoration plan is to enhance the sediment budget of the islands, they would be more able to adapt to changes in sea level over time.

5.15 Relationship between Short-term and Long-term Impacts

This section discusses the relationship between local short-term uses of the environment and any long-term impacts arising from those uses. It also examines long-term adverse cumulative impacts that may narrow the range of options for future use of resources. Potential impacts of the TSP and the other three restoration alternatives and the No-Action Alternative are discussed in Sections 5.2 through 5.13. Cumulative impacts are identified in Section 5.14.

Overall, there would be short-term minor (and therefore not significant) impacts on water quality and aquatic resources, including benthic invertebrates, fish, mollusks, crustaceans, and marine mammals. These would be outweighed by long-term maintenance of water quality (salinity) and improvements to nearshore and littoral habitats as a result of implementation of any of the restoration alternatives.

There would be short-term and long-term improvements in cultural resources due to the placement of additional sand in key locations, as this material would provide additional protection during future storm events. Short-term and long-term benefits to socio-economic conditions from the restoration alternatives would be expected due to the temporary increase in local construction jobs and long-term hurricane and storm damage risk reduction benefits.

5.16 Irreversible or Irretrievable Commitment of Resources

This section describes the irreversible and irretrievable commitment of resources associated with implementing the TSP or any of the other restoration alternatives considered. An irreversible commitment of resources occurs when a resource would be committed permanently to the project and unavailable for other use. An irretrievable commitment of resources refers to a use of a resource that would cause that resource to be unavailable for use in the future. Irretrievable resources could include minerals, cultural resources, or permanent changes in land use.

Restoration activities would result in the consumption of sand deposits in Mississippi Sound and the Gulf of Mexico, as well as fossil fuels for operation of dredging and placement equipment. The sand used would remain in Mississippi Sound but be located elsewhere in that system.

In general, impacts to biological resources would occur to individual organisms and small portions of populations. They would not constitute an irreversible commitment of resources, since the biological systems would be expected to recover. However, restoration activities on East Ship Island and West Ship Island would cause the conversion of approximately 800 acres of Mississippi Sound littoral habitat, including 365 acres of habitat at Camille Cut, to barrier island and wetland habitats. This change would cause a long-term alteration of the island habitat for biological resources and local hydrology and currents around the island.

5.17 Summary and Conclusions

A summary of the specific impacts of the TSP and the other alternatives considered in this SEIS is presented in Table ES-1. Implementation of the TSP to restore the Mississippi barrier island system would result in both negative and beneficial impacts to placement and borrow areas and to the users of these areas. These impacts would include the permanent loss of open water habitat at Camille Cut, construction-related disruptions to birds and other wildlife on Ship and Cat Islands, and construction-related disruptions to public use of borrow and placement areas. However, the overall significant long-term system-wide benefits to ecosystems, as well as economic benefits associated with damages and economic losses avoided and regional economic benefits, would outweigh the negative impacts. Most notably, the restoration of the islands, with critical economic, recreational, environmental, and aesthetic benefits, would help maintain and sustain Mississippi Sound and the coastal mainland. The MsCIP PEIS estimated $18.5 million in potential annual benefits from losses avoided through restoration of the barrier islands (USACE, 2009a [Table 4-2]). In addition, restoration would provide additional nesting habitat for threatened and endangered sea turtles and over-wintering critical habitat for the piping plover as well as habitat for neotropical migrants and waterfowl. Closure of Camille Cut would help to maintain the salinity regime in the Sound and the habitat conditions for oysters and numerous estuarine-dependent fish and crustacean species that are essential for commercial and recreational fishing. In addition, the barrier island restoration would contribute to continued protection of the significant historical and cultural sites within the GUIS. The anticipated reduction in storm surges would also help to protect unique coastal mainland habitats, wetlands, and special aquatic sites (including the Grand Bay NERR).

Based on the analysis of potential impacts in the SEIS, Borrow Site Option 4 was recommended for inclusion in the TSP. Borrow Site Option 1 is not feasible based on the costs of over $400 million, which exceeds the available funding. Borrow Site Option 4 ($368 million) is more costly than Borrow Site Options 2 ($330 million) or 3 ($341 million) due to the reduced use of DA-10 and higher use of sand from the PBP-AL site, which would require payment to the state of Alabama. Borrow Site Options 2 and 3, while less costly than Borrow Site Option 4, have been eliminated due to concerns from the NPS about the potential impacts to Sand Island and conflicts with NPS land use management policy.

6. Compliance with Environmental Requirements

6.1 Introduction

This section provides an overview of the laws, regulations and executive orders reviewed to ensure compliance by this SEIS and implementation of the TSP. If applicable, the compliance actions and consultation activities taken by the USACE are noted.

This SEIS will be used to support the NEPA compliance requirements for the USACE, the NPS, and the BOEM and, therefore, the list of laws, regulations, and Executive Orders included below include regulatory requirements that apply to all three agencies. The proposed project area includes portions of the GUIS, managed by the NPS, and therefore the proposed project must comply with applicable laws (e.g., Organic Act of 1916) and NPS management policies. BOEM, formerly known as the Minerals Management Service (MMS), has jurisdiction over all mineral resources on the Federal OCS, which includes the PBP-OCS borrow area. P.L. 103-426, enacted 31 October 1994, gave the MMS (now the BOEM) the authority to convey, on a noncompetitive basis, the rights to OCS sand, gravel, or shell resources for shore protection, beach or wetlands restoration projects, or for use in construction projects funded in whole or part or authorized by the Federal government. Those resources fall under the purview of the Secretary of the Interior, who oversees the use of OCS sand and gravel resources, and the BOEM as the agency charged with this oversight by the Secretary. After an evaluation required by NEPA, the BOEM may issue noncompetitive negotiated agreements for the use of OCS sand to the requesting entities. Therefore, BOEM, as a cooperating Federal agency, is undertaking a connected action (40 C.F.R. 1508.25) that is related, but unique from the USACE Proposed Action. The Proposed Action of the BOEM is the issuance of a negotiated agreement pursuant to its authority under the Outer Continental Shelf Lands Act. The purpose of that action is to authorize the use of OCS sand resources the Petit Bois OCS borrow site. In parallel with the USACE decision-making process, the BOEM will evaluate whether or not to authorize the use of the offshore borrow area.

6.2 Anadromous Fish Conservation Act

This act authorizes the Secretary of the Interior to enter into a cooperative agreements with the States and other non-Federal interests for the conservation, development, and enhancement of the Nation's anadromous fishery resources that are subject to depletion from water resources developments and other causes, or with respect to which the Federal government has made conservation commitments concerning such resources by international agreements. The program emphasizes the conservation and enhancement of anadromous fishery resources and the fish in the Great Lakes and Lake Champlain that ascend streams to spawn. The Act established a grant program to provide funding to states for habitat or fish enhancement work, and specifies cost-sharing and appropriation provisions.

Three anadromous fish species (Alabama shad, striped bass, and Gulf sturgeon) occur in the proposed project area. Based on the evaluation of potential impacts (Sections 5.4.4 and 5.4.8); there would be minor and temporary impacts on these fish species. Because the overall impacts would not be significant, the TSP would be in compliance with the Act.

6.3 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act of 1940, as amended, makes it illegal to take, transport, or possess bald and golden eagles or to engage in commerce in these species, with limited exceptions allowed. Section 5 includes an evaluation of potential impacts of the TSP on birds, including bald eagles, which are known to occur on the barrier islands. Because the proposed activity would not occur within identified nesting areas, USACE has determined that the TSP complies with the Act.

6.4 Clean Air Act

The CAA of 1990 is a Federal law that authorizes USEPA to regulate emissions of airborne pollutants, although the states do much of the work to implement the Act. Under this law, USEPA sets limits on how much of a pollutant can be present in an area anywhere in the United States. This promotes uniformity in basic health and environmental protections. In addition, the law recognizes that it is appropriate for states to take the lead in implementing the CAA because pollution control problems often require special understanding of local industries, geography, housing patterns, etc.

Under the CAA, States must develop State Implementation Plans (SIPs). An SIP is a collection of regulations to clean up areas that exceed applicable air quality standards.

The potential air quality impacts resulting from this project are discussed in Section 5. The discussion concludes that emissions would be minor and temporary. The area is currently in attainment for all NAAQS. The project would not result in exceedance of chronic or acute state air quality standards; therefore, the TSP is in compliance.

6.5 Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended, commonly called the Clean Water Act (CWA), authorizes the USEPA to regulate activities resulting in a discharge to navigable waters. Section 401 (33 U.S.C. § 1341) of the CWA specifies that any applicant for a Federal license or permit to conduct any activity that may discharge into navigable waters must obtain a certification that the discharge complies with applicable sections of the CWA. Section 401 of the CWA requires certification that activities, including dredge and fill activities, would not violate State water quality standards. Impacts associated with the discharge of dredged or fill material and for the building of structures in all waters of the United States are evaluated following guidelines implementing Section 404 of the CWA. Evaluation of the impacts associated with the placement of material related to the fill of Camille Cut and restoration of the southern shoreline of East Ship Island and the southern shoreline of Cat Island has been completed and is documented in Appendix P. On March 31, 2009 the MDEQ indicated that they supported the goals of the MsCIP Comprehensive Plan and that the elements described in the PEIS supported the goals of the State Water Quality program. Following review of the specific impacts associated with the TSP in this SEIS and

Section 404(b)(1) evaluation (see Appendix P), Section 401 water quality certification will be requested from the MDEQ.

6.6 Coastal Zone Management Act

The Coastal Zone Management Act (CZMA) (16 U.S.C. § 1451 et seq.) was enacted by Congress in 1972 to develop a national coastal management program that comprehensively manages and balances competing uses of and impacts on any coastal area or resource. The program is implemented by individual state coastal management programs in partnership with the Federal government.

According to the CZMA federal consistency requirement, 16 U.S.C. § 1456, federal activities must be consistent, to the maximum extent practicable, with a state's federally approved coastal management program. The federal consistency requirement is an important mechanism to address coastal effects, to ensure adequate federal consideration of state coastal management programs, and to avoid conflicts between states and federal agencies. The Coastal Zone Act Reauthorization Amendments of 1990 (P.L. 106-508), enacted on November 5, 1990, as well as the Coastal Zone Protection Act of 1996, amended and reauthorized the CZMA. The CZMA is administered by the Office of Ocean and Coastal Resource Management, within the NOAA National Ocean Service.

NOAA approved the Mississippi Coastal Program (MCP) in 1980. The MDMR is the lead agency, and the MCP resolves conflicts over local coastal uses. The authority guiding the MCP is the Coastal Marshlands Protection Act, which designates allowable use of the state's tidal wetlands. The MDMR has led a comprehensive planning effort, as described in the Comprehensive Resource Management Plan (NOAA, 2010c), which incorporates stakeholder interests in coastal development issues in Mississippi. On May 5, 2009 the MDMR concurred that the projects in the MsCIP Comprehensive Plan were consistent to the maximum extent practicable with the MCP and that these actions would not have adverse environmental effects on Mississippi coastal resources. The USACE determined that the TSP is consistent with the MCP to the maximum extent practicable and following review of the SEIS, the USACE will request MDMR's concurrence with USACE's determination.

6.7 Endangered Species Act

The ESA of 1973 (16 U.S.C. § 1531–1543), as amended, establishes a national policy designed to protect and conserve threatened and endangered species and the ecosystems upon which they depend. The ESA is administered by the Department of the Interior, through the USFWS, and by the USDOC, through NOAA Fisheries, National Marine Fisheries Service (NMFS), Protected Resource Division. Section 7 of the ESA specifies that any agency that proposes a federal action that could jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species (16 U.S.C. § 1536(a)(2)) must participate in the interagency cooperation and consultation process. The USACE has initiated formal consultation with both the USFWS and NOAA Fisheries and submitted a joint BA detailing the impacts associated with the TSP and the other restoration alternatives and proposed means to avoid, minimize, or mitigate impacts (Appendix N). As detailed in the BA, the USACE concluded that the project is in compliance with ESA. The SEIS and BA will be reviewed by the USFWS and NOAA

Fisheries to determine whether their agency concurs with the USACE's determination. The USFWS and NOAA Fisheries will issue a Biological Opinion on the action identifying reasonable and prudent measures to minimize impacts if determined necessary. If unacceptable adverse impacts to threatened or endangered species are identified by the USFWS or NOAA Fisheries, the agencies will recommend reasonable alternatives (16 U.S.C. § 1536 (b)(3)(A) [ESA Section 7]).

6.8 Estuary Protection Act 1968

The Estuary Protection Act of 1968 ((16 U.S.C. 1221–1226; P.L. 90-454; 82 Stat 625) was passed to highlight the values of estuaries and the need to conserve their natural resources while providing a means to achieve a balance between protection of resources and development. It authorized the Secretary of the Interior to take a variety of actions, including study and inventory of estuaries of the U.S., in cooperation with other federal agencies and the states. An adjunct to the Estuary Protection Act was the creation of the National Estuary Program (NEP) in 1987, through amendments to the CWA. The NEP was designed to identify, restore, and protect nationally-significant estuaries of the U.S., which are included in the program through a designation process. The USEPA administers the program, with committees consisting of local government officials, private citizens, and representatives from other federal agencies, academic institutions, industry, and estuary user-groups managing program decisions and activities.

Implementation of the barrier island restoration, as outlined in the TSP, would help to maintain the estuarine conditions in Mississippi Sound and, therefore, the project is fully supportive of the intent of the Act.

6.9 Magnuson-Stevens Fishery Conservation and Management Act

The Fishery Conservation and Management Act of 1976 (16 U.S.C. § 1801 et seq.) established the following:

- A fishery conservation zone between the territorial seas of the U.S. and 200 nautical miles offshore
- An exclusive U.S. fishery management authority over fish within the fishery conservation zone (excluding highly migratory species)
- Regulations for foreign fishing within the fishery conservation zone through international fishery agreements, permits, and import prohibitions

In 1996, Congress enacted amendments to the Act, known as the Sustainable Fisheries Act (P.L. 104-297), to address the substantially reduced fish stocks, which had declined as a result of direct and indirect habitat loss. The Act was renamed the Magnuson-Stevens Fishery Conservation and Management Act (P.L. 94-265), as amended on October 11, 1996. This act provides for the conservation and management of the fisheries, and the identification and protection of EFH (NOAA Fisheries, 1996).

EFH within the project area and potential impacts on fish species and associated essential habitats are evaluated in Sections 4 and 5 of this SEIS. The proposed TSP complies with the Act.

6.10 Marine Mammal Protection Act

Under the MMPA of 1972 (16 U.S.C. § 1361 et seq.), the Secretary of Commerce is responsible for all cetaceans and pinnipeds, except walruses, and has delegated authority for implementing the Act to the NOAA Fisheries. The Secretary of the Interior is responsible for walruses, polar bears, sea otters, manatees, and dugongs, and has delegated the responsibility for implementing the MMPA to the USFWS. The MMPA established the Marine Mammal Commission and its Committee of Scientific Advisors on Marine Mammals, whose members are responsible for overseeing and providing advice to the responsible regulatory agencies on all Federal actions bearing upon the conservation and protection of marine mammals.

Use of the proposed area and the potential impacts to marine mammals resulting from the TSP and protective measures to offset the potential impacts are considered in Sections 4 and 5. Incorporation of the safeguards used to protect threatened or endangered species during project implementation would also protect any marine mammals in the area; therefore, the project complies with this act.

6.11 The Marine Protection, Research, and Sanctuaries Act

The Marine Protection, Research, and Sanctuaries Act (MPRSA), also known as the Ocean Dumping Act, was passed in 1972 to prohibit the dumping of material into the ocean that would unreasonably degrade or endanger human health or the marine environment. Ocean dumping cannot occur unless a permit is issued under the MPRSA by the USACE for dredged material, USEPA's and subject to USEPA's concurrence, and by USEPA for all other materials. USEPA is also responsible for designating recommended ocean dumping sites for all types of materials as well as inspection, monitoring and surveillance to ensure compliance with disposal permit conditions.

The TSP includes the collection and placement of sand borrow material to restore Ship and Cat Islands and improve littoral transport of sand from the combined DA-10 and littoral zone site. Borrow investigations have indicated that the material is generally free of oil residue from the Deep Water Horizon oil spill and will not result in the placement of contaminated material. Procedures will be implemented during dredging and placement activities to identify potential oil contamination and avoid distribution of contaminated material. Placed material is for beneficial-use purposes and therefore, not governed by MPRSA but rather the CWA. MPRSA is not applicable to the TSP.

6.12 Migratory Bird Treaty Act

The Migratory Bird Treaty Act (MBTA) of 1918 established Federal responsibilities to protect birds migrating between the United States and Canada. Subsequent treaties with Mexico (1936), Japan (1972), and the Union of Soviet Socialist Republics (1976) expanded the scope of international protection of migratory birds. Each subsequent treaty was incorporated into the MBTA as an amendment. The provisions of the MBTA are implemented domestically within the signatory countries. Under the MBTA, nearly all species of birds occurring in the United States, their eggs, and their nests are protected. There are 836 bird species protected by the MBTA in the United States, 58 of which are legally hunted as game birds. The MBTA makes it illegal to take (to hunt, pursue, wound, kill, possess, or transport by any means) listed bird species, their eggs, feathers, or nests unless otherwise authorized, such as within legal hunting seasons. This SEIS evaluates the benefits and impacts of the TSP to migratory birds as described in Sections 4 and 5. The TSP is in compliance with the Act.

6.13 Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act of 1934, as amended, requires consultation and coordination with the USFWS and state fish and wildlife agencies "whenever the waters of any stream or other body of water are proposed or authorized to be impounded, diverted, the channel deepened, or the stream or other body of water otherwise controlled or modified for any purpose whatever, including navigation and drainage, by any department or agency of the United States, or by any public or private agency under Federal permit or license "(16 U.S.C. § 662(a)). The USFWS prepared an initial Fish and Wildlife Coordination Act Report (FWCAR) during the preparation of the MsCIP PEIS (USACE, 2009a). Information in this FWCAR was instrumental in guiding the development of the initial barrier island restoration plan. The USFWS subsequently prepared a FWCAR addressing the specifics of the barrier island restoration plan (Appendix Q) and complies with the Act.

6.14 National Environmental Policy Act

NEPA requires that all federal agencies use a systematic, interdisciplinary approach to document the potential impacts from federal actions on the environment. This approach promotes the integrated use of natural and social sciences in planning and decision-making that could have an impact on the environment. The NEPA regulations provide for the use of the NEPA process to identify and assess reasonable alternatives to proposed actions that avoid or minimize adverse effects of these actions upon the quality of the environment. Scoping is used to identify the scope and significance of environmental issues associated with a proposed federal action through coordination with federal, state, and local agencies; the general public; and any interested individuals and organizations prior to the development of an EIS. The process also identifies and eliminates from further detailed study issues that are not significant or have been addressed by prior environmental review.

According to 40 C.F.R. § 1502.9, a supplement to either a draft or final EIS (DEIS or FEIS) must be prepared if an agency makes substantial changes in the TSP that are relevant to environmental concerns, or there are significant new circumstances or information relevant to environmental concerns and bearing on the TSP or its impacts. The ROD for the MsCIP PEIS was signed by Assistant Secretary of the Army Jo-Ellen Darcy on January 14, 2010. The ROD, which included restoration of the Mississippi barrier islands, completed the NEPA process.

This SEIS has been prepared in accordance with the NEPA process for federal actions that may impact the environment and addresses new conditions that were not evaluated in the MsCIP PEIS. Specifically, this SEIS evaluates the sediment dredging and placement impacts associated with the following:

- Direct sand placement in Camille Cut between East Ship Island and West Ship Island
- Direct placement of sand on the southern shore of East Ship Island
- Direct placement of sand on the eastern shoreline of Cat Island
- Borrow of approximately 21 mcy of sand for closure of Camille Cut, restoration of East Ship Island, and restoration of Cat Island

6.15 National Historic Preservation Act

The NHPA, enacted in 1966 and amended in 1970 and 1980, provides for the NRHP to include districts, sites, buildings, structures, and objects significant in American history, architecture, archaeology, and culture. The law seeks to preserve the historical and cultural foundation of the United States. According to Executive Order 11593 of 1991 (*Protection and Enhancement of the Cultural Environment)*, the federal government will provide leadership in preserving, restoring, and maintaining the historic and cultural environment. The NHPA provides funding for each state to establish a SHPO. The SHPO oversees performance of appropriate surveys to ensure that historic and cultural resources are protected under the law. Consultation with the Mississippi SHPO has been initiated concerning the specific aspects of the TSP, as discussed in Sections 4 and 5 of the SEIS and in compliance with the Act.

The OCS is not federally owned land, and the Federal Government has not claimed direct ownership of historic properties on the OCS; therefore, under Section 106 of the NHPA, BOEM only has the authority to ensure that its funded and permitted actions do not adversely affect significant historic properties. Beyond avoidance of adverse impacts, BOEM does not have the legal authority to manage the historic properties on the OCS.

6.16 National Park Service Regulations

6.16.1 Organic Act of 1916 and NPS Management Policies 2006, Section 1.4: The Prohibition on Impairment of Park Resources and Values

Restoration of the Mississippi barrier islands as part of the MsCIP Comprehensive Plan will involve work within the GUIS and therefore must conform to the requirements of the NPS Organic Act of 1916 (Organic Act). By enacting the Organic Act, Congress directed the U.S. Department of Interior and the NPS to manage units "to conserve the scenery and the natural and historic objects and wildlife therein and to provide for the enjoyment of the same in such a manner and by such a means as will leave them unimpaired for the enjoyment of future generations" (16 U.S.C. § 1). Congress reiterated this mandate in the Redwood National Park Expansion Act of 1978 by stating that NPS must conduct its actions in a manner that will ensure no "derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress" (16 U.S.C. 1a-1).

NPS Management Policies 2006, Section 1.4.4, explains the prohibition on impairment of park resources and values:

> While Congress has given the Service the management discretion to allow impacts within parks, that discretion is limited by the statutory requirement (generally

> enforceable by the federal courts) that the Park Service must leave park resources and values unimpaired unless a particular law directly and specifically provides otherwise. This, the cornerstone of the Organic Act, establishes the primary responsibility of the National Park Service. It ensures that park resources and values will continue to exist in a condition that will allow the American people to have present and future opportunities for enjoyment of them.

The NPS has discretion to allow impacts on Park resources and values when necessary and appropriate to fulfill the purposes of a Park (NPS, 2006; Section 1.4.3). However, the NPS cannot allow an adverse impact that would constitute impairment of the affected resources and values (NPS, 2006; Section 1.4.3). An action constitutes an impairment when its impacts "harm the integrity of Park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values" (NPS, 2006; Section 1.4.5).

In making a determination of whether there would be an impairment, an NPS decision-maker must use his or her professional judgment (NPS, 2006; Section 1.4.7). This means that the decision-maker must consider any EAs or environmental impact statements (EISs) required by NEPA; consultations required under Section 106 of the NHPA; relevant scientific and scholarly studies; advice or insights offered by subject matter experts and others who have relevant knowledge or experience; and the results of civic engagement and public involvement activities relating to the decision (NPS, 2006; Section 1.4.7). At the time that a decision is made, a non-impairment determination will be prepared for the selected action and appended to the NPS decision document.

6.16.2 Director's Order #77-1, Wetland Protection

Executive Order 11990—*Protection of Wetlands*, directs all federal agencies to avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands and to avoid direct or indirect support of new construction in wetlands wherever there is a practicable alternative. In the absence of such alternatives, NPS parks must modify actions to preserve and enhance wetland values and minimize degradation. Consistent with Executive Order 11990 and NPS Director's Order #77-1: *Wetland Protection*, NPS has adopted a goal of "no net loss of wetlands." Director's Order #77-1 states that for new actions where impacts to wetlands cannot be avoided, proposals must include plans for compensatory mitigation that restores wetlands on NPS lands, where possible, at a minimum acreage ratio of 1:1.

For the purpose of implementing Executive Order 11990, an area in an NPS unit that is classified as a wetland according to the USFWS "Classification of Wetlands and Deepwater Habitats of the United States" is subject to Director's Order #77-1 (with the exception of deepwater habitats, which are not subject to Director's Order #77-1) (Cowardin et al., 1979). The Cowardin wetland definition encompasses more aquatic habitat types than the definition and delineation manual used by the USACE for identifying wetlands subject to Section 404 of the CWA. The 1987 "USACE Wetlands Delineation Manual" requires that three parameters (hydrophytic vegetation, hydric soil, wetland hydrology) must all be present in order for an area to be considered a wetland. The Cowardin wetland definition includes such wetlands, but also adds some areas that, though lacking vegetation and/or soils due to natural physical or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, and rocky shores). Under the Cowardin definition, a wetland must have one or more of the following three attributes:

1. At least periodically, the land supports predominantly hydrophytes (wetland vegetation).
2. The substrate is predominantly undrained hydric soil.
3. The substrate is non-soil and is saturated with water or covered by shallow water at some time during the growing season of each year.

The Cowardin wetland definition includes wetlands with one of the three criteria discussed above, but also adds some areas that, though lacking vegetation and/or soils due to natural physical or chemical factors such as wave action or high salinity, are still saturated or shallow inundated environments that support aquatic life (e.g., unvegetated stream shallows, mudflats, rocky shores). As stated above, deepwater habitats are not subject to Director's Order #77-1. The wetland/ deepwater habitat boundary is described in Cowardin et al. (1979) as a depth of 2 meters (6.6 feet) at low water, or at the limits of emergent or woody vegetation extending beyond this depth. The National Wetlands Inventory (NWI) of the USFWS produces information on the characteristics, extent, and status of the nation's wetlands and deepwater habitats. The USFWS definition of wetlands is similar to the NPS definition of wetlands in that only one of three parameters (hydric soils, hydrophytic vegetation, and hydrology) is required to characterize an area as a wetland, based upon the Cowardin Classification of Wetlands (Cowardin et al., 1979). NWI maps are prepared by the USFWS from the analysis of high altitude imagery and wetlands are identified based on vegetation, visible hydrology and geography. The wetlands depicted on NWI maps are based upon the Cowardin wetland definition and classification system (Cowardin et al., 1979), so (subject to ground-truthing) they are considered wetlands by the NPS. Director's Order #77-1 (Wetland Protection) establishes NPS procedures for implementing Executive Order 11990. This includes preparation of a Wetland Statement of Findings (WSOF) with sufficient information for assessing the potential wetland impacts of the proposed actions of NPS managed property. The WSOF for the TSP discussed in this SEIS is located in Appendix M.

6.16.3 Permitting Instrument for NPS Special Park Uses

All of Petit Bois, Horn, East Ship Island, West Ship Island, DA-10/Sand Island, and portions of Cat Island are located within the boundaries of the GUIS Mississippi unit under the jurisdiction of the NPS.

All special park uses that do not have a specific, approved permitting instrument require an NPS Special Use Permit. This SEIS and a separate NPS ROD shall constitute the record of environmental impact analysis and decision-making process for the portions of the MsCIP that directly affects units of the NPS. This means that if approved, the GUIS will undertake a federal action through the issuance of a Special Use Permit to the USACE to implement the portions of the selected action within the jurisdictional boundary of GUIS.

6.17 Outer Continental Shelf Lands Act

The OSC Lands Act defines the OCS as all submerged lands lying seaward of state coastal waters under U.S. jurisdiction. The law authorizes the U.S. Department of the Interior to lease OCS lands to prevent waste and conserve natural resources, and to grant leases to the highest responsible qualified bidder as determined by competitive bidding procedures. The Deepwater Port Act authorizes the Department of Transportation, after consultation with the Department of the Interior, to waive the removal requirements for a deepwater port if its components can be used in conjunction with a mineral lease sale. OCS leases or permits may be cancelled if continued activity is likely to cause serious harm to life, including fish and other aquatic life. Economic, social, and environmental values of the renewable and nonrenewable resources must be considered in management of the OCS. It is required that an environmental study be done for any region to be included in a lease sale, to assess and manage environmental impacts on the OCS. The TSP is in compliance with the Act.

The BOEM is the agency designated to oversee OCS resources. After an evaluation required by NEPA, the BOEM may issue noncompetitive negotiated agreements for the use of OCS sand to the requesting entities. Therefore, BOEM, as a cooperating Federal agency, is undertaking a connected action (40 C.F.R. 1508.25) that is related, but unique from the USACE Proposed Action. The Proposed Action of the BOEM is the issuance of a negotiated agreement pursuant to its authority under this Act and will evaluate whether or not to authorize the use of offshore borrow areas.

6.18 Rivers and Harbors Act

Section 10 of the Rivers and Harbors Act of 1899 prohibits the construction of structures or obstructions in navigable waters without the consent of Congress (33 U.S.C. § 407). Structures include wharves, piers, jetties, breakwaters, bulkheads, etc. The Rivers and Harbors Act also includes any changes to the course, location, condition, or capacity of navigable waters and includes dredge and fill projects in those waters. The USACE oversees implementation of this law.

This SEIS has been completed in coordination with appropriate entities of the USACE, Mobile District to ensure that no features of the barrier island restoration would obstruct navigation.

6.19 Submerged Lands Act

The Submerged Lands Act was enacted in response to litigation that effectively transferred ownership of the first 3 miles of a state's coastal submerged lands to the federal government. In response, Congress adopted the Submerged Lands Act in 1953, granting title to the natural resources located within 3 miles of their coastline (three marine leagues for Texas and the Gulf coast of Florida). For purposes of the Submerged Lands Act, the term "natural resources" includes oil, gas, and all other minerals. Mississippi calls the land between the mean low tide (MLT) and mean high tide (MHT) tidelands, and the land below MLT submerged lands (or submerged water bottoms) (Nature Conservancy, 2013).

Because the proposed project includes removal of sand within 3 miles of the coast (tidelands and submerged lands), it would require agreements with the states of Mississippi and Alabama. The USACE is coordinating with both Mississippi and Alabama in compliance with this act.

The State of Alabama owns the title to lands underlying coastal waters to a line 3 geographical miles distant from its coastline (see 43 U.S.C. § 1301, et seq.). The United States has paramount rights in these waters for purposes of commerce, navigation, national defense, and international affairs, none of which apply to the removal of sand for the purposes of beach or island restoration. Removal of sand within the state boundaries will be done in accordance with State Law (AL Code 9-15-52), and either a direct sale or royalty payment may be charged for removal.

6.20 Wilderness Act

The Wilderness Act established a National Wilderness Preservation System to be composed of federally owned areas designated by the Congress as "wilderness areas," and these shall be administered for the use and enjoyment of the American people in such manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness.

Approximately 1,800 acres of the National Seashore, Horn and Petit Bois Islands were designated wilderness areas in 1978 which prohibits commercial enterprise, permanent road, structures or installations; motorized vehicles and equipment are also prohibited (16 U.S.C. §1133(c)). The SEIS recognizes their Wilderness status and since the activity would not directly affect these areas, no action would be taken that would impact their designation. Therefore, the TSP is in compliance with the Act.

6.21 Executive Orders

6.21.1 Executive Order 13175—Consultation and Coordination with Indian Tribal Governments

Executive Order 13175 imposes requirements on the development of rules, policy or guidance that have tribal implications or preempt tribal laws. Tribal implications is defined as having substantial direct effects on one or more Indian tribes, on the relationship between the federal government and Indian tribes, or on the distribution of power and responsibilities between the federal government and Indian tribes. Tribal coordination has taken place for the MsCIP barrier island restoration.

The SEIS does not propose the development of rules, policy or guidance nor will it preempt tribal law, thus Executive Order 13175 is not applicable to this Project.

6.21.2 Executive Order 13158—Marine Protected Areas

The purpose of Executive Order 13158 is to help protect the significant natural and cultural resources within the marine environment for the benefit of present and future generations by strengthening and expanding the Nation's system of MPAs. Consistent with domestic and international law, the executive order seeks to:

(a) "strengthen the management, protection, and conservation of existing marine protected areas and establish new or expanded MPAs;

(b) develop a scientifically based, comprehensive national system of MPAs representing diverse U.S. marine ecosystems, and the Nation's natural and cultural resources; and

(c) avoid causing harm to MPAs through federally conducted, approved, or funded activities."

Federal MPAs fall into five categories: (1) marine sanctuaries, (2) national seashores, (3) wildlife refuges, (4) National Estuarine Research Reserves, and (5) National Estuary Programs as discussed in Sections 4 and 5 (Mississippi–Alabama Sea Grant Legal Program, 2003). A portion of the proposed project area is within the GUIS and is therefore considered an MPA. The TSP was developed in compliance with NPS regulations and management policies for the GUIS and is therefore addressed this executive order.

6.21.3 Executive Order 13112—Invasive Species

Executive Order 13112 was issued to prevent the introduction of invasive species; provide for their control; and minimize the economic, ecological, and human health impacts that invasive species can cause. This order defines invasive species, requires federal agencies to address invasive species concerns and to not authorize or carry out new actions that would cause or promote the introduction of invasive species, and established the Invasive Species Council.

Invasive species were considered during the development of the TSP. Dune plantings would consist of clean seed and/or native vegetation to discourage colonization by invasive species. Therefore, the TSP would not promote invasive species and would comply with this executive order.

6.21.4 Executive Order 13089—Coral Reef Protection

Executive Order 13089 established the interagency U.S. Coral Reef Task Force, co-chaired by the Secretary of the Interior and the Secretary of Commerce through the Administrator of the NOAA. The Task Force is charged with developing and implementing a comprehensive program of research and mapping to inventory, monitor, and "identify the major causes and consequences of degradation of coral reef ecosystems" while the executive order also directs Federal Agencies to expand their own research, preservation, and restoration efforts.

As noted in Sections 4.5.7 and 5.4.6, several fish havens, artificial reefs, and shipwrecks are located in the area; however, there is no hard bottom habitat or coral reefs in the proposed project area. Therefore, this executive order is not applicable.

6.21.5 Executive Order 13045—Protection of Children

On April 21, 1997, President Clinton issued Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.* This executive order directs each federal agency to ensure that its policies, programs, activities, and standards address disproportionate risks to children that result from environmental health risks or safety risks.

The potential environmental health or safety risks to children resulting from implementation of a restoration alternative are addressed in Section 5. Based on this evaluation, USACE has determined that the TSP addresses Executive Order 13045, *Protection of Children from Environmental Health Risks and Safety Risks.*

6.21.6 Executive Order 12898—Environmental Justice Policy

EJ Policy, based on Executive Order 12898 of 1994, requires agencies to incorporate into NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities. EJ is defined by the USEPA as the fair treatment and meaningful involvement of all people regardless of race, color, national origin, or income with respect to the development, implementation, and enforcement of environmental laws, regulations, and policies." The effects of the TSP on local populations and the resources used by local groups, including minority and low-income groups, are addressed in Section 5. Based on this evaluation, USACE has determined that the TSP addresses Executive Order 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations.*

6.21.7 Executive Order 11990—Protection of Wetlands

Executive Order 11990 requires that Federal agencies provide leadership and take action to minimize the destruction, loss, or degradation of wetlands; and preserve and enhance the natural beneficial values of wetlands when conducting the following actions:

- Acquiring, managing, and disposing of Federal lands and facilities
- Providing Federally undertaken, financed, or assisted construction and improvements
- Conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities

Agencies must avoid, to the extent possible, the long- and short-term adverse impacts associated with the destruction or modification of wetlands wherever there is a practicable alternative. As defined in Section 7(c) of Executive Order 11990, wetlands are areas that are inundated by surface or groundwater with a frequency sufficient to support and under normal circumstances do or would support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soil conditions for growth and reproduction. Under the TSP, no wetlands meeting this definition would be impacted by sand dredging or placement activities.

6.21.8 Executive Order 11988—Floodplain Management

Executive Order 11988 directs federal agencies to provide leadership and take action to reduce the risk of flood loss, to minimize the impact of floods on human safety, health, and welfare, and to restore and preserve the natural and beneficial values served by floodplains in carrying out their responsibilities. In addition, federal agencies are required to avoid to the extent possible adverse impacts associated with the occupation and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. The executive order applies to the following actions:

- Acquiring, managing, and disposing of federal lands and facilities
- Providing federally undertaken, financed, or assisted construction and improvements
- Conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities

The potential benefits from the Proposed Action on coastal flood risk are described in Section 5. The restoration of Ship and Cat Islands would help reduce the intensity of storm surges and storm waves, as well as the associated coastal flooding, as described in Appendix D. Therefore, the TSP meets the requirements of the floodplain management executive order.

7. Public Involvement

7.1 Introduction

NEPA is intended to ensure full public participation in the EIS process. Public participation includes effective communication between all federal, state, and local agencies, tribal governments, and other persons or organizations that may have an interest in the project. As required by NEPA, the public was invited to attend public scoping meetings and public hearings as part of the development of the MsCIP PEIS. Other methods used to reach the general public and interested stakeholders have included meeting announcements, newsletters, news releases to local print and broadcast news media, and a web site.

Further public communications included maintaining contact with public officials and agency representatives, ensuring that calls from the public were addressed in a timely manner, and contacting stakeholders. In addition, the SEIS was widely circulated and comments were requested. Public involvement materials are presented in Appendix R. These materials include copies of the Notice of Intent (NOI), newsletters, notices of public meetings, and the project mailing list. Agency correspondence is presented in Appendix R.

The public will be invited to review and comment on the Draft SEIS.

7.2 Notice of Intent

An NOI to prepare a Draft SEIS was published in 75 Fed. Reg. 203 on October 21, 2010. The NOI is included in the Public Involvement Report (Appendix R).

7.3 Public Scoping

Extensive public scoping was conducted during the development of the MsCIP Comprehensive Plan, of which the barrier island restoration is one part. According to the CEQ, public scoping is not required during the development of a SEIS (2007). Scoping completed for the PEIS is considered to be sufficient.

7.4 Distribution of the Draft and Final Supplemental Environmental Impact Statement

The Draft and Final SEIS documents will be posted on the MsCIP web site for public access and made available at local libraries.

7.5 Public Meeting/Open House

After the Draft SEIS is submitted for public review, a public meeting/open house will be held to discuss the proposed project activities. The meeting will be advertised and open to the public. The USACE will consider all comments received throughout the public review period and during the public meeting/open house when preparing the Final SEIS.

7.6 Point of Contact

Written comments regarding this SEIS should be sent to the following contact. Requests for more information may also be sent to the contact.

Susan Rees, Program Manager, MsCIP (Susan.I.Rees@usace.army.mil) or at this address:

U.S. Army Corps of Engineers
Department of Defense
P. O. Box 2288
Mobile, AL 36628

7.7 Cooperating Agencies

Per the CEQ regulations on implementing the NEPA, the USACE, Mobile District requested that several state and federal agencies accept the status of Cooperating Agency on the Integrated Report and Programmatic EIS. In response to this request, dated October 30, 2006, the entities outlined below are participating as cooperating agencies. During development of this SEIS, two Alabama agencies became cooperating agencies.

State

- Mississippi Department of Archives and History
- Mississippi Department of Environmental Quality, Office of Pollution Control
- Mississippi Department of Marine Resources
- Mississippi Department Of Transportation
- Mississippi Emergency Management Agency
- Mississippi Museum of Natural Science
- Mississippi Secretary of State, Public Lands Division
- Alabama Department of Conservation and Natural Resources

Federal

- Federal Emergency Management Agency, Region 4
- U.S. Department of Interior
  - Bureau of Ocean and Energy Management, Gulf of Mexico Region
  - National Park Service
  - U.S. Geological Survey
  - U.S. Fish and Wildlife Service
- U.S. Department of Commerce
  - National Oceanic and Atmospheric Administration, National Marine Fisheries Service Southeast Region, Protected Resources and Habitat Conservation Divisions
- U.S. Department of Agriculture
  - Natural Resources Conservation Service
- U.S. Department of Transportation, Federal Highway Administration
- U.S. Environmental Protection Agency, Region 4

8. List of Preparers and Participants

8.1 USACE, Mobile District

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Daniel Brown/ Superintendent, GUIS

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David Dunagan/Technical Editor/30 years of experience/Master of Arts

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Ruth C. Rouse, AICP/Project Scientist/24 years of experience/Master of Environmental Management

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Melanie S. Wiggins/Project Scientist/15 years of experience/Master of Applied Science-Environmental Policy and Management

Kira Zender/Environmental Planner/17 years of experience/Master of Urban and Regional Planning

8.4 David Miller and Associates

David Miller and Associates staff were involved with preparation of the socioeconomic resources sections:

Corey L. Miles/Environmental Scientist/8 years of experience/Master of Science

Michael McGarry/Senior NEPA Specialist, Senior Ecologist/23 years of experience/ Bachelor of Science, Natural Resources

David Miller/President, Senior Water Resources Planner/34 years of experience/MBA-Finance and Public Policy

9. References

Ache, B.W., J.D. Boyle, and C.E. Morse. 2000. *A Survey of the Occurrence of Mercury in the Fishery Resources of the Gulf of Mexico*. Prepared by Battelle for the USEPA Gulf of Mexico Program, Stennis Space Center, MS. January.

Adams, C.M, E. Hernandez, and J.C. Cato. 2004. The economic significance of the Gulf of Mexico related to population, income, employment, mineral, fisheries, and shipping. Ocean and Coastal Management 47: 565–80.

Alabama Current Connection. Spring 2011, Vol V, Issue 1.

Anderson, Donald M. 2010. Supported by NOAA/CSCOR/COP. *The Harmful Algae Page*. http://www.whoi.edu/redtide, web site accessed October 11.

Antonelis, G.A., J.D. Baker, T.C. Johanos, R.C. Braun, and A.L. Harting. 2006. Hawaiian monk seal (*Monachus schauinslandi)*: status and conservation issues. Atoll Research Bulletin 543:75–101.

Baker, J.D., C.L. Littnan, and D.W. Johnston. 2006. Potential effects of sea level rise on the terrestrial habitats of endangered and endemic megafauna in the Northwestern Hawaiian Islands. Endangered Species Research 2:21–30.

Balazs, G.H. 1982. Growth rates of immature green turtles in the Hawaiian Archipelago, pp.117-125.

Beck, M. W., M. Odaya, J. J. Bachant, J. Bergan, B. Keller, R. Martin, R. Mathews, C. Porter, G. Ramseur. 2000. Identification of Priority Sites for Conservation in the Northern Gulf of Mexico: An Ecoregional Plan. The Nature Conservancy, Arlington, VA.

Bemvenuti, C.E., L.G. Angonesi, and M.S. Gandra. 2005. Effects of dredging operations on soft bottom macrofauna in a harbor in the Patos Lagoon estuarine region of southern Brazil. Brazilian Journal of Biology 65(4):573–581.

Bernstein, M.A., J. Kim, P. Sorensen, M. Hanson, A. Overton, and S. Hiromoto. 2006. Rebuilding Housing Along the Mississippi Coast: Ideas for Ensuring an Adequate Supply of Affordable Housing. RAND Corporation Occasional Papers. http://www.rand.org/pubs/occasional_papers/OP162/

Black, D. E., D. K. Phelps, and R. L. Lapan. 1988. The effect of inherited contamination on egg and larval winter flounder, *Pseudopleuronectes americanus.* Marine Environmental Research. 25:45–62.

Blaxter J.H.S. 1969. Development: eggs and larvae. In: Hoar WS, Randall DJ, editors. Fish physiology-Vol. 3. New York (NY): Academic Press. p 177–252.

Blaxter, J.H.S. 1974. The Early Life History of Fish: the Proceedings of an International Symposium Held at the Dunstaffnage Marine Research Lab of Scottish Marine Biological Association at Oban, Scotland, May 17–23, 1973. Springer-Verlag, New York. 765 pp.

Blumberg, A.F., Q. Ahsan, and J. Lewis. 2000. Modeling hydrodynamics of the Mississippi Sound and Adjoining River, Bays and Shelf Water. OCEANS 2000 MTS/IEEE Conference and Exhibition, September 11–14, 2000.

Bolam, S.G. and H. L. Rees. 2003. Minimizing Impacts of Maintenance Dredged Material Disposal in the Coastal Environment: A Habitat Approach. Environmental Management Vol. 32, No. 2, pp. 171–88.

Brunn, P. 1962. "Sea Level Rise as a Cause of Shore Erosion." *Journal of Waterways and Harbors Division* (ASCE) 1:116–30.

Bureau of Ocean Energy Management (BOEM). 2013. Map of Active Leases and Infrastructure.

Bureau of Ocean Energy Management, Regulation and Enforcement (BOEM). 2010. Active Leases and Infrastructure (map).

Butler, Philip A. 1985. Synoptic Review of the Literature on the Southern Oyster Drill, *Thais haemastoma floridana*. NOAA NMFS. November 1985.

Byrnes, M. R., J. D. Rosati, and S. F. Griffee, 2012. *Littoral Sediment Budget for the Mississippi Sound Barrier Islands, Applied Coastal Research and Engineering*. July 2012.

Byrnes, M.R., Griffee, S.F., and Osler, M.S. 2010. "Channel dredging and geomorphic response at and adjacent to Mobile Pass, Alabama," ERDC/CHL-TR-10-8, U.S. Army Engineer Research and Development Center, Coastal and Hydraulics Laboratory, Vicksburg, MS.

Byrnes, Mark R., R. M. Hammer, T. D. Thibaut, and D. B. Snyder. 2004. Physical and Biological Effects of Sand Mining Offshore Alabama, USA. Journal of Coastal Research 20:1:6–24. Winter 2004.

Cake, Edwin W. 1983. Coastal Barrier Islands and Shellfish IN: Proceedings of the Northern Gulf of Mexico Estuaries and Barrier Islands Research Conference.

California Air Resources Board. 1999. Source Inventory Categories #1194-1196, Tugs & Towboats, Dredge Vessels and Others. Accessed via: http://www.arb.ca.gov/homepage.htm, web site accessed February 5, 2008.

California State Lands Commission (CSLC), Monterey Bay National Marine Sanctuary, and Aspen Environmental Group. 2005. Draft Environmental Impact Report/Environmental Impact Statement. http://www.montereybay.noaa.gov/new/2005/031505marseir.html, web site accessed on January 23, 2007.

Carr, A.F., D.R. Jackson, and J.B. Iverson. 1979. Marine turtles. Chapter XIV In A summary and analysis of environmental information on the Continental Shelf and Blake Plateau from Cape Hatteras to Cape Canaveral (1977). Vol. I, Book 3. Center for Natural Areas, South Gardiner, Maine.

Chambers, R. C., W. C. Leggett, and J. A. Brown. 1988. Variation in and among early life history traits of laboratory-reared winter flounder (*Pseudopleuronectes americanus*). Marine Ecology Progress Series 47: 1–15.

Chapman, Raymond S., Alison S. Grzegorzewski, Phu V. Luong, Ernest R. Smith, S. Jarrell Smith and Michael W. Tubman. 2012. Mississippi Coastal Improvement Program (MsCIP). Effects of DA-10 Removal on Circulation and Sediment Transport Potential within Horn Island Pass and Lower Pascagoula Sound Channels. ERDC Coastal and Hydraulics Laboratory. June 2012.

Chessa, L. A., M. Scardi, S. Serra, A. Pais, P. Lanera, N. Plastina, L.M. Valiante, and D. Vinci. 2007. Small-scale perturbation on soft bottom macrozoobenthos after mechanical cleaning operations in a Central-Western Mediterranean lagoon. Transitional Waters Bulletin 2(2007):9–19.

Cho, H. C. and C. A. May. 2006. An Initial Restoration Tool for Submersed Aquatic Vegetation. National wetlands newsletter, Vol. 28, No. 6.

Christmas, J.Y. and R.S. Waller. 1973. Estuarine Vertebrates. In: Christmas, J.Y. (ed). Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Phase IV, Biology. Gulf Coast Research Laboratory, Ocean Springs, MS.

Cipriani, L.E. and G.W. Stone. 2001. Net Longshore Sediment Transport and Textural Changes in Beach Sediments Along the Southwest Alabama and Mississippi Barrier Islands, U.S.A. Journal of Coastal Research, 17: 443–58.

City-data.com. 2010. http://www.city-data.com (November 15, 2010).

Clarke, Douglas, C. Dickerson, and K. Reine. 2002. Characterization of Underwater Sounds Produced by Dredges. US Army Engineer Research and Development Center.

Coleman, Andrew/IMMS. 2012. Personal communication with USACE. Marine Turtle Research, Institute for Marine Mammal Studies.

Coleman, Andrew/IMMS. 2013. Personal communication Paul Necaise/USFWS. Email dated July 5, 2013.

Compton, R. Goodwin L. Handy, R. and Abbott, V. 2008 A critical examination of worldwide guidelines for minimising the disturbance to marine mammals during seismic surveys. Marine Policy 32: 255-262.

Cowardin, L.M., V. Carter, F.C. Golet, and E.T. LaRoe. 1979. Classification of Wetlands and Deepwater Habitats of the United States. U.S. Fish and Wildlife Service Report No. FWS/OBS/-79/31. Washington, D.C. December.

Council on Environmental Quality (CEQ). 2007. A Citizen's Guide to the NEPA: Having Your Voice Heard. Executive Office of President of the U.S.

Cutler, J.K. and Mahadevan, S. 1982. *Long-Term Effects of Beach Nourishment on the Benthic Fauna of Panama City Beach, Florida*. Miscellaneous Report No. 82-2. U.S. Army Corps of Engineers Coastal Engineering Research Center, Fort Belvoir, VA. Daehnick, A.E., M.J. Sullivan, and C.A. Moncreiff. 1992. Primary Production of the Sand Microflora in Seagrass Beds of Mississippi Sound. Botanica Marina 35:131–39.

Delgado, James P., ed. 1997. *Encyclopedia of Underwater and Maritime Archaeology*. British Museum Press. London. 1997.

Ehrhart, L.M. 1977. Cold water stunning of marine turtles in FL east coast lagoons: rescue measures, population characteristics and evidence of winter dormancy.

Eleuterius, Lionel N. 1981. The Marine Flora of Mississippi Sound: A Review. Symposium on Mississippi Sound June 25–26.

ERDC (Engineer Research and Development Center). 2012. Unpublished report, Gulf Sturgeon telemetry study in Mississippi Sound, MS Barrier Islands.

Evans, W.E. 1999. Elements of Studies of Protected Species in the Gulf of Mexico: History, Philosophy, and Research. Gulf of Mexico Marine Protected Species Workshop, MMS, Gulf of Mexico OCS Region.

Executive Order 12898. 1994. *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*. 59 Federal Register 7629. http://www.epa.gov/lawsregs/laws/eo12898.html. February 16.

Executive Order 13045. 1997. *Protection of Children from Environmental Health Risks and Safety Risks*. 62 *Federal Register* 19883. http://www.epa.gov/lawsregs/laws/eo13045.html. April 23.

Florida Marine Research Institute. 2001. Florida's Inshore and Nearshore Species: 2001 Status and Trends Report. St. Petersburg, Florida.

Frazier, D.E. 1967. Recent deltaic deposits of the Mississippi River: their development and chronology: Gulf Coast Association of Geological Societies, Transactions, v. 17, p. 287-315.

Frazer, N.B. and L.M. Ehrhart. 1985. Preliminary growth models for green, *Chelonia mydas*, and loggerhead, *Caretta caretta*, turtles in the wild. Copeia 1985:73-79.

Fritts, T.H., Hoffman, and M.A. McGehee. 1983. The distribution and abundance of marine turtles in the Gulf of Mexico and nearby Atlantic waters. J. Herpetology 17(4): 327-344.

Garrison, J.R. Jr. and S. Smelley. 2007. Recovery of Infaunal Crustacean Colonies Following a Period of Rapid Sedimentation and Defaunation: A Neoichnological Examination Following Beach Rejuvenation on the South Side of Packery Channel, North Padre Island, Texas: Gulf Coast Association of Geological Societies Transactions, 57, 305-317.

Gulf Coast Ecosystem Restoration Task Force, 2011.

Gulf Islands National Seashore (GUIS). 2007. Eagle observations.

Gulf of Mexico Fishery Management Council (GMFMC). 1998. Generic amendment for addressing EFH requirements in the following Fishery Management plans of the Gulf of Mexico: Shrimp Fishery Of The Gulf Of Mexico, United States Waters; Red Drum Fishery Of The Gulf Of Mexico, Reef Fish Fishery Of The Gulf Of Mexico, Coastal Migratory Pelagic Resources (Mackerel) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery Of The Gulf Of Mexico, Spiny Lobster Fishery Of The Gulf Of Mexico; and Coral And Coral Reefs Of Mexico, Gulf of Mexico Fishery Management Council, 3018 U.S. Highway 301N., Suite 1000, Tampa, Florida 33619.

Gulf of Mexico Fishery Management Council (GMFMC). 2004. Final Environmental Impact Statement for the Generic Essential Fish Habitat Amendment to the following fishery management plans of the Gulf of Mexico (GOM): Shrimp Fishery Of The Gulf Of Mexico, Red Drum Fishery Of The Gulf Of Mexico, Reef Fish Fishery Of The Gulf Of Mexico, Stone Crab Fishery Of The Gulf Of Mexico, Coral And Coral Reef Fishery Of The Gulf Of Mexico, Spiny Lobster Fishery Of The Gulf Of Mexico And South Atlantic, Coastal Migratory Pelagic Resources Of The Gulf Of Mexico And South Atlantic. Volume 1: Text. March 2004.

Gulf of Mexico Fishery Management Council (GMFMC). 2005. Generic amendment Number 3 for Addressing Essential Fish Habitat Requirements, Habitat Areas of Particular Concern, and Adverse Effects of Fishing in the following Fishery Management Plans of the Gulf of Mexico: Shrimp Fishery Of The Gulf Of Mexico, United States Waters; Red Drum Fishery Of The Gulf Of Mexico, Reef Fish Fishery Of The Gulf Of Mexico, Coastal Migratory Pelagic Resources (Mackerel) in the Gulf of Mexico and South Atlantic; Stone Crab Fishery Of The Gulf Of Mexico, Spiny Lobster Fishery Of The Gulf Of Mexico; and Coral And Coral Reefs Of Mexico.

Gulf States Marine Fisheries Commission (GSMFC). 2010. License and Fees for Alabama, Florida, Mississippi, and Texas in Their Marine Waters for the year 2009, September 2010, No 186.

Gulfbase. 2013. General Facts about the Gulf of Mexico. Website: http://www.gulfbase.org/facts.php. Accessed 4/24/2013.

Gulfbase.org. 2010. Mississippi Sound. Website: http://www.gulfbase.org/bay/view.php?bid = mississippi, accessed 12/02/2010.

Gunter, G. 1981. Status of turtles on MS coast. Gulf Research Report 7(1):89-92.

Hammersten, Susan. 1991. French Warehouse Site National Register of Historic Places Inventory Nomination Form. Southeast Archaeological Center. October 2.

Handley, L., D. Altsman, and R. DeMay, eds. 2007. Seagrass Status and Trends in the Northern Gulf of Mexico: 1940–2002. U.S. Geological Survey Scientific Investigations Report 2006-5287 and U.S. Environmental Protection Agency 855-R-04-003. 267 p.

Hildebrand, John. 2003. Sources of Anthropogenic Sound in the Marine Environment. http://www.mmc.gov/sound/internationalwrkshp/pdf/hildebrand.pdf, web site accessed on January 23, 2007.

Hoese, H.D. and R.H. Moore. 1998. Fishes of the Gulf of Mexico: Texas, Louisiana, and Adjacent Waters, Second Edition. Texas A&M Press, College Station, TX.

Hopkins, G. 2011. Spoil Island/Sand Island—Shorebird nesting data. June 1.

Hopkins, Gary/NPS. 2012. Personal communication with USACE. Ocean Springs, MS.

Institute for Marine Mammal Studies (IMMS). 2007. http://www.dolphinsrus.com/dolphins.php. Accessed January 17, 2007.

Jarrell, J.D., M. Mayfield and E. N. Rappaport. 2001. NOAA Technical Memorandum NWSTPC-1: The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900-2000. http://www.aoml.noaa.gov/hrd/Landsea/deadly/index.html. Accessed November 29, 2010.

Jarrell, J.P. 1981. Hydrodynamics of Mobile Bay and Mississippi Sound Pass-Exchange Studies. Mississippi-Alabama Sea Grant Consortium MASGP-80-023.

Kelley, Sean W. and Sarah F. Griffee. 2013. Simulating the Potential Impact of Borrow Site Excavation on Sediment Transport along the Gulfstream Pipeline, Petit Bois Pass, Alabama. Final Report. July 2013.

Kindinger, Jack L., Jennifer L. Miselis, and Noreen A. Burton. In press. The Shallow Stratigraphy and Sand Resources Offshore of Cat Island, MS.

Kipple, B.M., and C.M. Gabriele. 2007. Underwater noise from skiffs to ships, in Piatt, J.F., and Gende, S.M., eds., Proceedings of the Fourth Glacier Bay Science Symposium, October 26–28, 2004: U.S. Geological Survey Scientific Investigations Report 2007-5047, p. 172–75.

Kjerfve, B. 1986. Comparative oceanography of coastal lagoons, pp. 63–81. In: Estuarine Variability. D.A. Wolfe (ed.). Academic Press. 509 pp.

Kjerfve, B. and J.E. Sneed. 1984. Analysis and Synthesis of Oceanographic Conditions in the Mississippi Sound Offshore Region. Final Report Volume 1. University of South Carolina Department of Geology

Leeworthy, V.R. and P.C. Wiley. 2001. Current Participation Patterns in Marine Recreation, National Survey on Recreation and the Environment 2000. U.S. Dept. of Commerce, NOAA, National Ocean Service, Special Projects Publication. Silver Spring, MD.

Lindberg, W.J. and M.J. Marshall. 1984. Species Profiles: Life histories and environmental requirements of coastal fishes and invertebrates (South Florida)—Stone crab. U.S. Fish Wildl. Serv. FWS/OBS-82/11.21. U.S. Army Corps of Engineers. TR-EL-82-4.

Ludwick, J.C. 1964. Sediments of the Northeastern Gulf of Mexico. In: Miller, R.L., (ed.), Papers in Marine Geology: Shepard Commemorative Volume: MacMillan: New York. P. 204–38.

Lynch, T., J. Harrington, and J. O'Brien. 2003. Economic Impact Analysis of Coastal Ocean Observing Systems in the Gulf Coast Region. Center for Economic Forecasting and Analysis and the Center for Ocean-Atmospheric Prediction Studies, Florida State University. December 2003.

Macauley, John M., Lisa M. Smith, Linda C. Harwell, and William H. Benson. 2010. Impacts of Hurricane Katrina, Sediment Quality in Near Coastal Waters of the Gulf of Mexico: Influences of Hurricane Katrina. Setac Press, Environmental Toxicology and Chemistry, Vol. 29, No. 7, pp. 1403–1408, 2010.

Maddock, S.B. 2010. *Final Report Wintering Piping Plover Surveys 2008–2009 Boca Chica, Texas to Marco Island, Florida December 2, 2008–March 13, 2009*. August 22.

Maddox, Dawn. 1971. Fort Massachusetts National Register of Historic Places Inventory Nomination Form. Mississippi Depart of Archives and History. March 25, 1971.

Marsh, B. 2010. Mississippi Barrier Islands: A guide for kayakers, Hikers, Campers, and Naturalists. Accessed via: http://www.barrierislandsms.com/guide.htm. Accessed December 15, 2010.

McGurk, M. D. 1986. Natural mortality of marine pelagic fish eggs and larvae: role of spatial patchiness. Marine Ecology Progress Series 34: 227–42.

Miles, D.W. 1950. The life histories of the seatrout, Cynoscion nebulosus, and the redfish, *Sciaenops ocellatus*. Texas Game Fish Oyster Comm. Marine Lab. Annu. Rep. 1949–1950.

Minerals Management Service (MMS). 1991. Mississippi-Alabama Continental Shelf Ecosystem Study Data Summary and Synthesis. U.S. Dept. of the Interior, MMS, Gulf of Mexico OCS Region. OCS Study MMS 91-0062. December 1991. New Orleans.

Minerals Management Service (MMS). 2000. Cetaceans, Sea Turtles, and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance, and Habitat Associations. http://www.gomr.boemre.gov/homepg/whatsnew/techann/000002.html, Accessed December 2, 2010.

Minerals Management Service (MMS). 2006. *Historic Shipwrecks of the Gulf of Mexico: A Teacher's Resource*. Gulf of Mexico OCS Region. United States Department of the Interior. May.

Mississippi Code of 1972. 2003. Coastal Wetlands Protection ActTitle 49, Chapter 27, Section 1-71. Revised through 2003 State Legislative Session.

Mississippi Department of Employment Security (MDES). 2010. Labor Force and Establishment Based Employment, Annual Averages 2001 Forward.

Mississippi Department of Environmental Quality (MDEQ). 2006a. State of Mississippi Water Quality Assessment 2006, 305b report.

Mississippi Department of Environmental Quality (MDEQ). 2006b. National Coastal Assessment Data for Mississippi Sound 2000–2004.

Mississippi Department of Environmental Quality (MDEQ). 2007. State of Mississippi Water Quality Criteria for Intrastate, Interstate, and Coastal Waters. Jackson, MS. August.

Mississippi Department of Environmental Quality (MDEQ). 2010a. 2010 Mississippi 2010 Statewide 305b report. Obtained from: http://www.deq.state.ms.us/mdeq.nsf/page/FS_SurfaceWaterQualityAssessments?OpenDocument.

Mississippi Department of Environmental Quality (MDEQ). 2010b. Mississippi Fish Tissue Advisories and Commercial Fishing Bans. http://deq.state.ms.us/Mdeq.nsf/page/FS_Fish_Tissue?OpenDocument. Accessed October 11, 2010.

Mississippi Department of Environmental Quality (MDEQ). 2010c. Air Quality Planning and Emissions Standards. http://www.deq.state.ms.us/MDEQ.nsf/page/Air_AirQualityPlanningandEmissionStandards?OpenDocument. Accessed December 2, 2010.

Mississippi Department of Marine Resources (MDMR). 2005. *Mississippi Gulf Coast National Heritage Area Management Plan*. Comprehensive Resource Management Planning. Biloxi, Mississippi. December.

Mississippi Department of Marine Resources (MDMR). 2010a. Offshore reefs. http://www.dmr.state.ms.us/Fisheries/Reefs/offshore-reefs.htm. Accessed November 29, 2010.

Mississippi Department of Marine Resources (MDMR). 2010b. Shrimping. http://www.dmr.state.ms.us/Fisheries/shrimping.htm. Accessed October 11, 2010.

Mississippi Department of Marine Resources (MDMR). 2010c. Crabbing. http://www.dmr.state.ms.us/Fisheries/crabbing.htm. Accessed October 11, 2010.

Mississippi Department of Marine Resources (MDMR). 2010d. Gulf Ecological Management Sites. http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Round-Island.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Ship-Island.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Petit-Bois.htm, http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Horn-Island.htm, and http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Cat-Island.htm. Accessed November 30, 2010.

Mississippi Department of Marine Resources (MDMR). 2010e. Coastal Preserves Program. http://www.dmr.state.ms.us/coastal-ecology/preserves/cp-home.htm and http://www.dmr.state.ms.us/Coastal-Ecology/Preserves/properties/preserves-properties.htm. Accessed December 1, 2010.

Mississippi Department of Marine Resources (MDMR). 2010f. Seasons and Regulations. http://www.dmr.state.ms.us/Regulations/seasons.htm. Accessed October 11, 2010.

Mississippi Department of Marine Resources (MDMR). 2010g. Shrimp Fishery, Marketing. http://www.dmr.state.ms.us/Marketing/Seafood-Mkt/shrimp-fishery.htm. Accessed October 11, 2010.

Mississippi Department of Marine Resources (MDMR). 2010h. Oystering. http://www.dmr.state.ms.us/Fisheries/oystering.htm. Accessed October 11, 2010.

Mississippi Department of Transportation (MDOT). 2004. *Mississippi Unified Long Range Transportation Infrastructure Plan (MULTIPLAN) Phase 1.* http://www.mdotmultiplan.com.Accessed November 17, 2010.

Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP). 2005. Mississippi's Comprehensive Wildlife Conservation Strategy 2005–2015. Mississippi Museum of Natural Science. Version 1.1.

Mississippi Emergency Management Agency (MSEMA). 2012. http://www.msema.org/about/, http://www.msema.org/about/local.html

Mississippi Governor's Office of Recovery and Renewal. 2007. *Mississippi Recovery Fact Sheet,* http://www.governorbarbour.com/recovery/documents/RecoveryFactSheet1/2/2007.pdf Accessed November 17, 2010.

Mississippi Gulf Coast. 2006. http://www.gulfcoast.org/static/index.cfm?contentID = 328. Accessed November 17, 2010.

Mississippi Museum of Natural Science. 2005. Mississippi's Comprehensive Wildlife Conservation Strategy. Mississippi Department of Wildlife, Fisheries, and Parks. Mississippi Museum of Natural Science, Jackson, Mississippi.

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. 2008. Gulf Hypoxia Action Plan 2008.

Mississippi State Port Authority at Gulfport (MSPA). 2010. *Port Facilities and Infrastructure* http://www.shipmspa.com/facilities.htm. Accessed November 16, 2010.

Mississippi State Tax Commission. 2013. Casino Gross Gaming Revenues website. Accessed 5/1/13.

Mississippi State University (MSU). 2004. http://www.msstate.edu/dept/GeoSciences/(November 16, 2010).

Mississippi–Alabama Sea Grant Legal Program. 2003. Marine Protected Areas in the Gulf of Mexico: A Survey. Edited by Stephanie Showalter and Lisa C. Schiavinato.

Mitson, R. B. and H. P. Knudsen. 2003. Causes and effects of underwater noise on fish abundance estimation. Aquatic Living Resources 16: 255–63.

Modde, Timothy, and Stephen T. Ross. 1981. Seasonality of Fishes Occupying a Surf Zone Habitat in the Northern Gulf of Mexico. Fishery Bulletin: Vol 78, No. 4.

Moncreiff, C. A., M. J. Sullivan, and A. E. Daehnick. 1992. "Primary Production Dynamics in Seagrass Beds of Mississippi Sound: the Contributions of Seagrass, Epiphytic Algae, Sand Microflora and Phytoplankton." *Marine Ecology Progress Series.* 87:161–71.

Moncreiff, C. A., T. A. Randall, and J. D. Caldwell. 1998. Mapping of Seagrass Resources in Mississippi Sound. Report to the MS Department of Marine Resources. BY3-156-3238. Ocean Springs, Mississippi: University of Southern Mississippi, Gulf Coast Research Laboratory.

Moncreiff, Cynthia A. 2006. Statewide Summary for Mississippi (Seagrasses). http://pubs.usgs.gov/sir/2006/5287/pdf/StatewideSummaryforMississippi.pdf

Moore, F.R., P. Kerlinger, and T.R. Simons. 1990. Stopover on a Gulf Coast barrier island by spring trans-Gulf migrants. Wilson Bulletin 102(3):487–500.

Morton, R.A. 2008. *Historical changes in the Mississippi-Alabama barrier-island chain and the roles of extreme storms, sea level, and human activities.* Journal of Coastal Research 24(6):1587–1600.

Morton, R.A., T.L. Miller, and L.J. Moore. 2004. National Assessment of Shoreline Change: Part 1: Historical Shoreline Changes and Associated Coastal Land Loss Along the U.E. Gulf of Mexico. U.S. Geological Survey Open-File Report 2004-1043, 42 p. http://pubs.usgs.gov/of/2004/1043.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (USFWS). 1991. Recovery Plan for U.S. Population of Atlantic Green Turtle. National Marine Fisheries Service, Washington, D.C.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (USFWS). 1993. Recovery Plan for Hawksbill Turtles in the U.S. Caribbean Sea, Atlantic Ocean, and Gulf of Mexico. National Marine Fisheries Service. St. Petersburg, Florida. 58 p

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (USFWS). 2003. Critical Habitat Designation for Gulf Sturgeon in *Federal Register* 68:53 pages 13369–418.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (USFWS). 2007. Green Sea Turtle (*Chelonia mydas*) 5-Year Review and Evaluation.

National Marine Fisheries Service (NOAA Fisheries) and U.S. Fish and Wildlife Service (USFWS). 2008. Recovery Plan for the Northwest Atlantic Population of the Loggerhead Sea Turtle (Caretta caretta), Second Revision. National Marine Fisheries Service, Silver Spring, MD.

National Marine Fisheries Service (NOAA Fisheries), U.S. Fish and Wildlife Service (USFWS), and SEMARNAT. 2010. Bi-National Recovery Plan for the Kemp's Ridley Sea Turtle (Lepidochelys kempii), Second Revision. National Marine Fisheries Service. Silver Spring, Maryland. 155 pp. + appendices.

National Marine Fisheries Service (NOAA Fisheries). 1996. Fishery Conservation and Management Act, Public Law 94-265, October 11, 1996, http://www.nmfs.noaa.gov/sfa/magact/ mag1.html, web site accessed January 24, 2007.

National Marine Fisheries Service (NOAA Fisheries). 2004a. Environmental Impact Statement for shrimp, red drum, reef fish, coastal migratory pelagic resources, stone crab, spiny lobster, and coral and coral reefs.

National Marine Fisheries Service (NOAA Fisheries). 2004b. Annual Commercial Landings by Group. http://www.st.nmfs.gov/st1/commercial/landings/gc_runc.html (November 17, 2010).

National Marine Fisheries Service (NOAA Fisheries). 2009a. Recovery Plan for Smalltooth Sawfish (Pristis pectinata). Prepared by the Smalltooth Sawfish Recovery Team for the National Marine Fisheries Service, Silver Spring, Maryland.

National Marine Fisheries Service (NOAA Fisheries). 2009b. Endangered and Threatened Species; Critical Habitat for the Endangered Distinct Population Segment of Smalltooth Sawfish. Federal Register /Vol. 74, No. 169 /Wednesday, September 2, 2009

National Marine Fisheries Service (NOAA Fisheries). 2010a. Protected Resources. Websites: http://www.nmfs.noaa.gov/pr/species/esa/mammals.htm, http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/, and http://www.nmfs.noaa.gov/pr/species/mammals/cetaceans/bottlenosedolphin.htm, accessed 12/02/2010.

National Marine Fisheries Service (NOAA Fisheries). 2010b. Annual Commercial Landing Statistics. http://www.st.nmfs.gov/st1/commercial/landings/gc_runc.html, web site accessed October 4, 2010.

National Marine Fisheries Service (NOAA Fisheries). 2010c. Total Commercial Fishery Landings at an Individual U. S. Port. http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html, web site accessed October 4, 2010.

National Marine Fisheries Service (NOAA Fisheries). 2010d. Total Commercial Fishery Landings for Mississippi by Month. http://www.st.nmfs.noaa.gov/pls/webpls/MF_MONTHLY_LANDINGS.RESULTS, web site accessed October 11, 2010.

National Oceanic and Atmospheric Administration (NOAA). 1985. Gulf of Mexico coastal and ocean zones strategic assessment: Data Atlas. U.S. Department of Commerce. NOAA, NOS. December 1985.

National Oceanic and Atmospheric Administration (NOAA). 2004. Coastview Volume 2 Ecosystem Description: Hypoxia in the Gulf of Mexico. http://www.csc.noaa.gov/products/ gulfmex/html/rabalais.htm, accessed January 22 and 26, 2007.

National Oceanic and Atmospheric Administration (NOAA). 2010a. What is the Loop Current. http://oceanservice.noaa.gov/facts/loopcurrent.html. Accessed December 2, 2010.

National Oceanic and Atmospheric Administration (NOAA). 2010b. National Marine Sanctuaries. http://sanctuaries.noaa.gov/about/faqs/welcome.html and http://sanctuaries.noaa.gov/about/southeast.html. Accessed November 29, 2010.

National Oceanic and Atmospheric Administration (NOAA). 2010c. Ocean and Coastal Resource Management. http://coastalmanagement.noaa.gov/mystate/ms.html.Accessed December 13, 2010.

National Oceanic and Atmospheric Administration (NOAA). 2013. Gulf Spill Restoration. www.gulfspillrestoration.noaa.gov and http://www.gulfspillrestoration.noaa.gov/restoration/early-restoration/early-restoration-projects-atlas/, site accessed 9/25/13.

National Park Service (NPS). 1992. *National Register Bulletin Number 20. Nominating Historic Vessels and Shipwrecks to the National Register of Historic Places*. Secretary of the Interior, Washington, D. C.

National Park Service (NPS). 2000. Guidelines for Evaluating and Registering Archeological Properties bulletin.

National Park Service (NPS). 2006. *Management Policies 2006: The Guide to Managing the National Park System*. Section 1.4: The Prohibition on Impairment of Park Resources and Values. www.nps.gov/policy/mp/policies.html. August 31.

National Park Service (NPS). 2010a. Gulf Islands National Seashore. http://www.nps.gov/guis/index.htm and http://www.nps.gov/guis/naturescience/animals.htm, http://www.nps.gov/guis/parknews/park-significance.htm, http://www.nps.gov/guis/parknews/presskit.htm, and http://www.nps.gov/guis/historyculture/fort-massachusetts.htm. Accessed November 30, 2010, December 1, 2010, and December 2, 2010.

National Park Service (NPS). 2010b. Archaeology Program. Abandoned Shipwreck Act. http://www.nps.gov/archaeology/tools/laws/asa.htm. Accessed November 30, 2010.

National Park Service (NPS). 2010c. Public Use Statistics Office. Gulf Islands National Seashore. http://www.nature.nps.gov/stats/viewReport.cfm. Accessed November 17, 2010.

National Park Service (NPS). 2011. Sand Island Shorebird Nesting Summary. July 14.

National Park Service (NSP). 2012. National Park Service Procedural Manual #77-1: Wetland Protection. 42pgs.

National Research Council (NRC). 2003. Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. Ocean Noise and Marine Mammals. http://books.nap.edu/openbook.php?record_id = 10564&page = R1. Accessed December 2, 2010.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life. NatureServe, Arlington, Virginia. Website: http://www.natureserve.org/explorer.

Necaise, Paul/USFWS. 2012. Personal communication. As cited in the Biological Assessment for the Mississippi Coastal Improvements Program, Barrier Island Restoration. Prepared by USACE, Mobile District, 2012.

New Jersey Department of Environmental Protection. 2007. *Status of the Red Knot (*Calidris canutus rufa*) in the Western Hemisphere.* New Jersey Dept. of Env. Protection. Division of Fish and Wildlife. Prepared for U.S. Fish and Wildlife Service.

Newcombe, C.P. and J.O.T. Jensen. 1996. *Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact*. North American Journal of Fisheries Management. Vol. 16. pp. 693–27.

Newell, R.C., L.J. Seider, N.M. Simpson, and J.E. Robinson. 2004. Impacts of Marine Aggregate Dredging on Benthic Macrofauna off the South Coast of the United Kingdom. Journal of Coastal Research 20:1 pp. 115–25.

Ogren, L. 1977. Survey and reconnaissance of sea turtles in the northern Gulf of Mexico. Unpublished report NMFS.

Otvos, E. G., Jr. 1973. Geology of Mississippi-Alabama coastal area and nearshore zone: Guidebook, Field Trip May 19-20, 1973. The New Orleans Geological Society, 67 p.

Otvos, E.G. 1978. New Orleans - south Hancock Holocene barrier trends and origin of Lake Pontchartrain: Transactions - Gulf Coast Association of Geological Societies, v. 28, p. 337-355.

Otvos, E.G. 1979. Barrier Island Evolution and History of Migration, North Central Gulf Coast. In: Leatherman, S.P. (ed.), Barrier Islands from the Gulf of St. Lawrence to the Gulf of Mexico. New York, Academic Press. pp. 273–90.

Otvos, E.G. 1981. Barrier island formation through nearshore aggradation: stratigraphic and field evidence: Marine Geology, v. 43, p. 195-203.

Otvos, E.G. 1994. Mississippi's Revised Neogene Stratigraphy in Northern Gulf Context: 44th Annual convention of the Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists Regional Meeting, and the 41st Annual convention of the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists, p. 541–54.

Otvos, E.G. and Carter, G.A. 2008. “Hurricane degradation – barrier development cycles, northeastern Gulf of Mexico: landform evolution and island chain history,” Journal of Coastal Research, 24(2), 463-478.

Otvos, Ervin G. and Marco J. Giardino. 2004. Interlinked barrier chain and delta lobe development, northern Gulf of Mexico. Journal of Sedimentary Geology 169 (2004) 47–73.

Pattillo, M.E., T.E. Czapla, D.M. Nelson, and M.E. Monaco. 1997. *Distribution and Abundance of Fishes and Invertebrates in Gulf of Mexico Estuaries* Volume II: Species Life History Summaries. ELMR Report No. 11. NOAA/NOS Strategic Environmental Assessments Division, Silver Spring, MD.

Pearson, J. C. 1929. Natural history and conservation of the redfish and other commercial sciaenids on the Texas Coast. Bull. U.S. Bur. of Fisheries, 44:129–214.

Penland, S., Suter, J.R., and Boyd, R. 1985. Barrier island arcs along abandoned Mississippi River deltas: Marine Geology, v. 63, p. 197-233.

Perret, W. S., J. E. Weaver, R. C. Williams, F. L. Johanson, T. D. McIlwain, R. C. Raulerson, and W. M. Tatum. 1980. Fishery profiles of red drum and spotted seatrout. Gulf States Mar. Fish. Comm., Ocean Springs, MS. No. 6.

Perry, Harriet M. 2010. Excerpt of Chapter 11, Book 2, *Marine Resources and History of the Gulf Coast*.http://www.dmr.state.ms.us/Fisheries/shrimping.htm. Accessed October 11, 2010.

Peters, K.M. and R.H. McMichael. 1987. Early life history of the red drum, *Sciaenops ocellatus* (Pisces: Sciaenidae) in Tampa Bay. In: Estuaries. Vol. 10, No. 2.

Port of Pascagoula. 2010. http://portofpascagoula.com. Accessed November 16, 2010.

Rakocinski, C.F., R.W. Heard, T. Simons, and D. Gledhill. 1991. Macroinvertebrate associations from beaches of selected barrier islands in the Northern Gulf of Mexico: Important environmental relationships. Bull. Mar. Sci. 48(3): 689–701.

Rakocinski, C.F., R.W. Heard, S.E. LeCroy, H.A. McLelland, and T. Simons. 1993. Seaward change and zonation of the sandy-shore macrofauna at Perdido Key, Florida, USA. Estuar. Coast. Shelf Sci. 36: 81–104.

Rakocinski, C.F., R. W. Heard, S. E. LeCroy, J. A. McLelland, T. Simons. 1996. Journal of Coastal Research, Volume 12, No 1: Responses by Macrobenthic Assemblages to Extensive Beach Restoration at Perdido Key, Florida, U.S.A.

Rakocinski, C.F., S.E. LeCroy, J.A. McLelland, and R.W. Heard. 1998. Nested spatiotemporal scales of variation in sandy-shore macrobenthic community structure. Bull. Mar. Sci. 63(2): 343–62.

Renaud, M.L. 1995. Movements and submergence patterns of Kemp's ridley turtles (Lepidochelys kempii). Journal of Herpetology 29: 370-374.

Renaud, M.L. and J.A. Carpenter. 1994. Movements and submergence patterns of Loggerhead turtles (*Caretta caretta*) in the Gulf of Mexico determined through Satellite Telemetry. Bulletin of Marine Science. Volume 55, Number 1.

Richardson, W.J., C.R. Greene, Jr., C.I. Malme, D.H. Thomson with contributions by S.E. Moore and B. Würsig. 1995. Marine Mammals and Noise.

Richardson, W. J., B. Würsig and C. R. Greene. 1990. Reactions of bowhead whales, Balaena mysticetus, to drilling and dredging noise in the Canadian Beaufort Sea. Marine Environmental Research 29(2):135-160.

Ridgway, S. H., Wever, E. G., McCormick, J. G., Palin, J. and Anderson, J. H. 1969. Hearing in the giant sea turtle, *Chelonia mydas*. Proc. Natl. Acad. Sci. 64, 884-890

Rosati, J.D. and G.W. Stone. 2009. Geomorphologic evolution of barrier islands along the northern U.S. Gulf of Mexico and implications for engineering design in barrier restoration. Journal of Coastal Research. Retrieved November 15, 2010 from accessmylibrary: http://www.accessmylibrary.com/article-1G1-192974456/geomorphologic-evolution-barrierislands.html.

Ross, J.P. 1981. Historical decline of Loggerhead, Ridley, and Leatherback sea turtles, p. 189-195, In K.A. Bjorndal, 1981.

Ross, S.T. 1983. *A Review of Surf Zone Ichthyofaunas in the Gulf of Mexico*. S.V. Shabica, N.B. Cofer, and E.W. Cake (eds.), IN: Proceedings of the Northern Gulf of Mexico Estuaries and Barrier Islands Research Conference. U.S. Department of the Interior National Park Service, Southeast Region Office, Atlanta, GA. pp. 2534.

Ross, S.T., W.T. Slack, R.J. Heise, M.A. Dugo, H. Rogillio, B.R. Bowen, P. Mickle, and R.W. Heard. 2009. Estuarine and Coastal Habitat Use of Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) in the North-Central Gulf of Mexico. Estuaries and Coasts 32:360–74.

Rothschild, Susan B. 2004. Beachcomber's Guide to Gulf Coast Marine Life, 3rd Edition. Texas, Louisiana, Mississippi, Alabama, and Florida. Taylor Trade Publishing.

Saloman, Carl, Steven P. Naughton, and John L. Taylor. 1982. Benthic community response to dredging borrow pits, Panama City Beach, Florida / by Carl H. Saloman, Steven P. Naughton, and John L. Taylor; prepared for U.S. Army, Corps of Engineers, Coastal Engineering Research Center. Report no. 82-3.

Saloman, C.H. and Naughton, S.P. 1984. *Beach Restoration with Offshore Dredged Sand: Effects on Nearshore Macroinfauna*. Technical Memorandum NMFS-SEFC-133. National Oceanic and Atmospheric Administration, Washington, D.C.

Saloman, C.H., Naughton, S.P., Taylor J.L. 1982. "The Benthic Community Response to Dredging Borrow Pits, Panama City Florida." Report submitted to the USACE Coastal Engineering Research Center.

Saucier, R.T. 1963. Recent geomorphic history of the Pontchartrain Basin: Louisiana State University Studies, Coastal Studies Series, v. 9, 114pp.

Schmid, J.R. and W.N. Witzell. 1997. Age and growth of wild Kemp's ridley turtles (*Lepidochelys kempii*): cumulative results of tagging studies in FL. Chelonian Conserv. Biol. 2: 532-537.

Segrest, Natalie Guidron/Mississippi Department of Environmental Quality (MDEQ). 2010. Personal communication with Frank McFadden/McFadden Engineering concerning water quality in Mississippi Sound. November 29.

Seim, H.E., B. Kjerfve, and J.E. Sneed. 1987. Tides of Mississippi Sound and the Adjacent Continental Shelf. Estuarine, Coastal and Shelf Science: 25: 143–56.

Ship Island Excursions. 2010. www.msshipisland.com. Accessed November 17, 2010.

Simmons, E.G. and J.P. Brewer. 1962. A study of redfish (*Sciaenops ocellatus Linnaeus*) and black drum (*Pogonias cromis Linnaeus*). Pub. Of Inst. Mar. Sci., Univ. Texas. 8:184–211.

Simonson, David R./USCG. 2012. Personal communication with Doug Baughman/ CH2M HILL. Email dated August 1, 2013.

Stout, J.B. and A.A. de la Cruz. 1981. Symposium on Mississippi Sound. Marshes of Mississippi Sound: State of the Knowledge.

Thompson, M.J., W.W. Schroeder, N.W. Phillips, and B.D. Graham. 1999. USGS in cooperation with MMS. Ecology of Live Bottom Habitats of the Northeastern Gulf of Mexico: A Community Profile. January 1999. Report Number USGS/BRD/CR 1999-001 and OCS Study MMS 99-0004.

Turcotte, W. H. and D.L. Watts. 2009. Birds of Mississippi. Mississippi Department of Wildlife, Fisheries, and Parks.

Twichell, David, Pendleton, Elizabeth, Baldwin, Wayne, Foster, David, Flocks, James, Kelso, Kyle, DeWitt, Nancy, Pfeiffer, William, Forde, Amell, Krick, Jason, and Baehr, John. 2011. *The Shallow Stratigraphy and Sand Resources Offshore of the Mississippi Barrier Islands.*

Upshaw, C.F., W.B. Creath, and F.L. Brooks. 1966. Sediments and Microfauna off the Coast of Mississippi and Adjacent States. Mississippi Geological Economic and Topographic Survey Bulletin No. 106. pp 9–72.

U.S. Army Corps of Engineers (USACE), Mobile District. 1982. Benthic Macroinfauna Community Characterizations in Mississippi Sound and Adjacent Waters. Final Report. October.

U.S. Army Corps of Engineers (USACE). 1975. A Study of the Effects of Maintenance Dredging on Selected Ecological Parameters in the Gulfport Ship Channel, prepared by Water and Air Research, Inc.

U.S. Army Corps of Engineers (USACE). 1978. Technical Report D-77-24. Aquatic Disposal Field Investigations Duwamish Waterway Disposal Site, Puget Sound Washington, Appendix I.

U.S. Army Corps of Engineers (USACE). 1983. A Study of the Benthic Macrofauna at the Central Long Island Disposal Site.

U.S. Army Corps of Engineers (USACE). 1993. Monitoring Cruise at the Western Long Island Sound Disposal Site, July 1990. Prepared by SAIC.

U.S. Army Corps of Engineers (USACE). 1999. National Demonstration Program, Thin-Layer Dredged Material Disposal, Gulfport, Mississippi, 1991–1992. Mobile, AL.

U.S. Army Corps of Engineers (USACE). 2002. *Draft Environmental Impact Statement/Environmental Impact Report for San Diego Harbor Deepening (Central Navigation Channel)*. Prepared by EDAW, Inc.

U.S. Army Corps of Engineers (USACE). 2005. *Singing River Island, Mississippi Sound Gulf Sturgeon Critical Habitat Benthic Community Assessment*. Prepared by Vittor and Associates, Inc.

U.S. Army Corps of Engineers (USACE). 2007a. *Environmental Impact Statement for the Gulfport Offshore Ocean Dredged Material Disposal Site Designation*. Prepared by CH2M HILL.

U.S. Army Corps of Engineers (USACE). 2007b. Texas City Channel Deepening Project. Draft General Conformity Determination. Prepared by Berger/EA-JV.

U.S. Army Corps of Engineers (USACE). 2008. Waterborne Commerce of the United States: Part 2—Waterways and Harbors Gulf Coast, Mississippi River System and Antilles.

U.S. Army Corps of Engineers (USACE). 2009a. *Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi, Comprehensive Plan and Integrated Programmatic Environmental Impact Statement.* Main report and appendices. June.

U.S. Army Corps of Engineers (USACE). 2009b. *Mississippi Coastal Improvements Program, Hancock, Harrison, and Jackson Counties, Mississippi, Comprehensive Plan Report*. Report of the Chief Engineers. September 15.

U.S. Army Corps of Engineers (USACE). 2009c. *Final Supplemental Environmental Impact Statement for Gulfport Harbor Navigation Channel Gulfport, Mississippi.* Prepared by CH2M HILL, Inc. August.

U.S. Army Corps of Engineers (USACE). 2010a. *Record of Decision, Mississippi Coastal Improvements Program (MsCIP), Hancock, Harrison, and Jackson Counties, Mississippi*. Signed by the Assistant Secretary of the Army for Civil Works. January 14.

U.S. Army Corps of Engineers (USACE). 2010b. *Environmental Assessment Mississippi Coastal Improvements Program (MsCIP) Barrier Islands Restoration Plan: West Ship Island North Shore Restoration.* Mississippi Sound, Harrison County, Mississippi. Mobile District. August.

U.S. Army Corps of Engineers (USACE). 2010c. *Final Supplemental Environmental Impact Statement for Pascagoula Harbor Navigation Channel*. Mobile District. Prepared by CH2M HILL, Inc. May.

U.S. Army Corps of Engineers (USACE). 2011a. http://education.usace.army.mil/navigation/dredging.html. Accessed September 22, 2011.

U.S. Army Corps of Engineers (USACE). 2011b. Mississippi Coastal Improvements Program, Comprehensive Barrier Island Restoration, Developing Sustainable Restoration Alternatives.

U.S. Bureau of Labor Statistics. 2009. Employment Status of the Civilian Noninstitutional Population, 1940 to Date.

U.S. Census Bureau. 2000. *State and County Quick Facts*. http://quickfacts.census.gov/qfd/index.html. Accessed November 15, 2010.

U.S. Census Bureau. 2006. *Special Population Estimates for Impacted Counties in the Gulf Coast Area.* http://www.census.gov/Press-Release/www/emergencies/impacted_gulf_estimates.html. Accessed November 17, 2010.

U.S. Census Bureau. 2010. Building Permits. http://censtats.census.gov/bldg/bldgprmt.shtml. Accessed November 16, 2010.

U.S. Coast Guard (USCG). 2010. *Station Information, Station Gulfport.* http://www.uscg.mil/d8/staGulfport/ (November 22, 2010).

U.S. Department of Agriculture. 1995. Description of the Ecoregions of the United States. http://www.fs.fed.us/land/ecosysmgmt/index.html Accessed November 15, 2010.

U.S. Environmental Protection Agency (USEPA) and U.S. Army Corps of Engineers (USACE). 1991. Evaluation of dredged material proposed for ocean disposal. EPA503/8-91/001.

U.S. Environmental Protection Agency (USEPA). 1974. Information Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety. EPA/ONAC 550/9-74-004. March.

U.S. Environmental Protection Agency (USEPA). 1986. Environmental Impact Statement for the Pensacola, FL, Nearshore Mobile, AL, and Gulfport, MS. Dredged Material Disposal Site Designation (1986). USEPA Region 4. EPA 904/9-86-143. Prepared by U.S. EPA, Region 4.

U.S. Environmental Protection Agency (USEPA). 1991. *Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site Located Offshore Pascagoula, Mississippi*. July. Prepared by U.S. EPA, Region 4.

U.S. Environmental Protection Agency (USEPA). 1999. The ecological condition of estuaries in the Gulf of Mexico. EPA 620-R-98-004. July.

U.S. Environmental Protection Agency (USEPA). 2001. National Coastal Condition Report. National Coastal Condition Report (2001) Download Site. http://www.epa.gov/owow/oceans/nccr/downloads.html. Accessed January 22 and 26, 2007.

U.S. Environmental Protection Agency (USEPA). 2002. Commercial Marine Emission Inventory Development: Final Report. Assessment and Standards Division, Office of Transportation and Air Quality. EPA420-R-02-019. July 2002.

U.S. Environmental Protection Agency (USEPA). 2003. EPA Press Release: EPA proposed Quality of Life Standards to Minimize the Impacts of the Hudson River cleanup on Local Communities. http://yosemite.epa.gov/opa/admpress.nsf/7144dd430c47561885257018004c77a3/b14c7bb8c221eb088525715300683d75!OpenDocument. Accessed on January 23, 2007.

U.S. Environmental Protection Agency (USEPA). 2008. National Coastal Condition Report III, Chapter 5.

U.S. Environmental Protection Agency (USEPA). 2010. National Ambient Air Quality Standards, revised 6/2/10. http://www.epa.gov/air/criteria.html. Accessed September 27, 2011.

U.S. Environmental Protection Agency (USEPA). 2012. Mississippi Sound Water Quality Monitoring Data, 2000–2011. http://watersgeo.epa.gov/mwm/

U.S. Fish and Wildlife Service (USFWS) and Gulf States Marine Fisheries Commission. 1995. Gulf Sturgeon Recovery Plan. Atlanta, GA. 170pp.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries (NOAA Fisheries). 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. Federal Register: March 19, 2003 (Volume 68, Number 53) pages 13369–418. http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname = 2003_register&docid = fr19mr03-15. Accessed December 1, 2010.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries (NOAA Fisheries). 2009. Gulf Sturgeon (Acipenser oxyrinchus desotoi) 5-Year Review: Summary and Evaluation.

U.S. Fish and Wildlife Service (USFWS) and National Marine Fisheries (NOAA Fisheries). 2010. Endangered and Threatened Species; Proposed Listing of Nine Distinct Population Segments of Loggerhead Sea Turtles as Endangered or Threatened; Proposed Rule. Federal Register: March 16, 2010 (Volume 75, Number 50) pages 12597-12656. http://frwebgate. access. gpo.gov/cgi-bin/getdoc.cgi?dbname = 2010_register&docid = fr16mr10-19 Accessed December 2, 2010.

U.S. Fish and Wildlife Service (USFWS). 1982. Eastern Indigo Snake Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 23pp.

U.S. Fish and Wildlife Service (USFWS). 1990a. Alabama Red-bellied Turtle Recovery Plan. U.S. Fish and Wildlife Service, Jackson, Mississippi. 17 pp.

U.S. Fish and Wildlife Service (USFWS). 1990b. Gopher Tortoise Recovery Plan. U.S. Fish and Wildlife Service, Jackson, Mississippi. 28 pp.

U.S. Fish and Wildlife Service (USFWS). 1991. Mississippi Sandhill Crane Recovery Plan. U.S. Fish and Wildlife Service, Atlanta, Georgia. 42 pp.

U.S. Fish and Wildlife Service (USFWS). 1993a. Inflated heelsplitter (*Potamilis inflatus*) Recovery Plan. U.S. Fish and Wildlife Service. Jackson, Mississippi. 15pp.

U.S. Fish and Wildlife Service (USFWS). 1993b. Yellow-blotched Map Turtle (Graptemvs flavimaculata) Recovery Plan. U.S. Fish and Wildlife Service. Jackson, Mississippi. 18 pp.

U.S. Fish and Wildlife Service (USFWS). 1996. Piping Plover (*Charadnus melodus*), Atlantic Coast Population, Revised Recovery Plan. Hadley, Massachusetts. 258 pp.

U.S. Fish and Wildlife Service (USFWS). 2010a. Piping Plover Critical Habitat Questions and Answers. http://www.fws.gov/plover/q&a.html. Accessed December 15, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010b. U.S. Fish and Wildlife Service Species Assessment and Listing Priority Assignment Form Scientific Name: *Percina aurora*, Suttkus and Thompson 1994.

U.S. Fish and Wildlife Service (USFWS). 2010c. Species Profile for Mississippi Gopher Frog (Rana capito sevosa). Species Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = D031. Accessed November 29, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010d. Species Profile for Louisiana quillwort (Isoetes louisianensis). Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = S00T. Accessed November 29, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010e. Species Profile for Alabama Red-Belly turtle (Pseudemys alabamensis). Species Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = C01W. Accessed November 29, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010f. Species Profile for Green sea turtle (Chelonia mydas). Species Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = C00S. Accessed November 29, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010g. Species Profile for Kemp's Ridley sea turtle (*Lepidochelys kempii*). Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = C00O. Accessed November 29, 2010.

U.S. Fish and Wildlife Service (USFWS). 2010h. Species Profile for Piping Plover (*Charadrius melodus*). Reports: Environmental Conservation Online System. http://ecos.fws.gov/speciesProfile/profile/speciesProfile.action?spcode = B079. Accessed November 29, 2010.

U.S. Fish and Wildlife Service. 2010i. *Red Knot (*Calidris canutus rufa*) Spotlight Species Action Plan*. U.S. Fish and Wildlife Service, New Jersey Field Office.

U.S. Fish and Wildlife Service (USFWS). 2010j. National Wildlife Refuge System. http://www.fws.gov/mississippisandhillcrane/ and http://www.fws.gov/refuges/profiles/index.cfm?id = 43617.

U.S. Fish and Wildlife Service (USFWS). 2013. Endangered and Threatened Wildlife and Plants; Proposed Threatened Status for the Rufa Red Knot (*Calidris canutus rufa*); Proposed Rule. Federal Register /Vol. 78, No. 189 /Monday, September 30, 2013.

U.S. Geological Survey (USGS). 1982. Depositional History of Louisiana-Mississippi Outer Continental Shelf. By Jack L. Kindinger, Ronald J. Miller, Charles E. Stelting, and Arnold H. Bouma. Open File Report 82-1077.

U.S. Geological Survey (USGS). 2006. Open File Report 03-337. An Overview of Coastal Land Loss: With Emphasis on the Southeastern United States. http://pubs.usgs.gov/of/2003/of03-337/hurricanes.html. Accessed November 15, 2010.

United States Geological Survey (USGS). 2007. Bird Checklists of the United States; Gulf Islands National Seashore. http://www.npwrc.usgs.gov/resource/birds/chekbird/r4 /gulfisle.htm. Accessed January 19, 2007.

U.S. Geological Survey (USGS). 2012. Summary of Water Quality Data, Mississippi Sound at East Ship Island Light. http://waterdata.usgs.gov/ms/nwis/uv?site_no = 301527088521500.

U.S. Geological Survey (USGS). 2013. Hypoxia in the Gulf of Mexico, website: http://toxics.usgs.gov/hypoxia/hypoxic_zone.html. Accessed 4/24/13.

U.S. Geological Survey Open-File Report 2011-1173, at http://pubs.usgs.gov/of/2011/1173/.

University of Rhode Island. 2003. Office of Marine Programs. Science of Sound in the Sea. http://www.dosits.org/science/ssea/2.htm. Accessed on January 16, 2007.

University of Southern Mississippi. 2010. Migratory Bird Research Group Research Data Archive. http://www.usm.edu/mbrg/Archive.html. Accessed December 2, 2010.

Velardo, Brian. 2005. *Detailed Geochronology of the Mississippi Sound During the Late Holocene*. Master of Science Thesis Submitted to Louisiana State University and Agricultural and Mechanical College. May.

Vinogradova, N., S. Vinogradov, D. Nechaev, V. Kamenkovich, A. Blumberg, and Q. A. Honghai Li. 2005. Evaluation of the northern Gulf of Mexico Littoral Initiative Model based on the observed temperature and salinity in the Mississippi Bight. Marine Technology Society Journal 39(2):25–38.

Vittor, B.A. 1981. Benthic Community Characterization of Mississippi Sound. Symposium on Mississippi Sound. Sponsored by Mississippi Bureau of Marine Resources, USACE, Mississippi-Alabama Sea Grant Consortium, and Mississippi Cooperative Extension Service.

Vittor and Associates, Inc. 2011. Mapping of Submerged Aquatic Vegetation in 2010 Mississippi Barrier Island Restoration Project.

Vittor and Associates, Inc. 2013. *Mississippi Coastal Improvement Program (MsCIP), Mississippi Sound and the Gulf of Mexico Benthic Macroinfauna Assessment*. Submitted to U.S. Army Corps of Engineers, Mobile District. February 2013.

D.J.R. Walstra, J.H. de Vroeg, J.S.M. van Thiel de Vries, C. Swinkels1, A.P. Luijendijk, W.P. de Boer, R. Hoekstra, B. Hoonhout, J. Henrotte, T. Smolders, F. Dekker, and E. Godsey. 2012. A Comprehensive Sediment Budget for the Mississippi Barrier Islands, Proc. Int. Conf. Coastal Engineering (ICCE), ASCE.

Waring, Gordon T., Elizabeth Josephson, Katherine Maze-Foley, and Patricia E. Rosel, Editors. 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2012. Volume 1. March 2013.

Williams, Jolene/NPS. 2013. Personal communication with Lekesha Reynolds/USACE. Email dated July 31, 2013.

Wilson, K.V., Jr., M.G. Clair, II, D.P. Turnipseed, and R.A. Rebich. 2009. Development of a Watershed Boundary Dataset for Mississippi: U.S. Geological Survey Open-File Report 2008–119.

Winstead, N./Mississippi Museum of Natural Science. 2012. Personal communication with Jolene Williams/NPS, March 20.

Zdravkovic, Margo 2009. Nonbreeding bird census. Unpublished report. National Audubon Society. Coastal Bird Conservation Program.

Zdravkovic, M. 2010. Coastal Bird Conservation. 2009–2010 Mississippi Coast Survey Data.