Final Environmental Impact Statement

Bayou Casotte Harbor Channel Improvement Project
Pascagoula, Mississippi

Prepared for:
Jackson County Port Authority
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Pascagoula, MS 39567

PORT OF PASCAGOULA

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COVER SHEET

Responsible Agency and Lead Federal Agency: U.S. Army Corps of Engineers (USACE)

Title: Final Environmental Impact Statement (FEIS) for the Bayou Casotte Harbor Channel Improvement Project

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Abstract: This FEIS analyzes the potential environmental consequences of improvements to the Port of Pascagoula's Lower Pascagoula and Bayou Casotte Channels and associated future operations and maintenance (O&M). A Notice of Intent (NOI) was published in the Federal Register (FR) on February 4, 2010, to inform the public of the USACE's intent to prepare an EIS for the improvements to the Federal deep-draft Pascagoula Harbor navigation channel in Jackson County, Mississippi. There were plans that were found to be viable and technically feasible, the Non-Federal sponsor, Jackson County Port Authority (JCPA) locally preferred plan (LPP) and the plan that maximizes net benefits. The plan that maximizes net benefits recommends widening the navigation channel 50 feet on both sides along with the incorporation of bend easing north of Horn Island Pass. The LPP of the non-Federal sponsor recommends widening the navigation channel 100 feet to the west approximately 38,549 feet (~7.3 miles) in length along with bend easing north of Horn Island Pass. The northern portion of the Horn Island Pass Channel would be widened as necessary to facilitate (ease) the transition between the two channel segments. The tentatively selected plan is the non-Federal sponsor's LPP. Disposal operations for both plans consist of placing dredged material within the Pascagoula Ocean Dredged Material Disposal Site (ODMDS) and the Littoral Zone Placement Area (LZPA). Future O&M dredged material would be placed within several areas including pre-existing open-water disposal areas adjacent to the channel, LZPA, and/or the Pascagoula ODMDS. Approximately 3.6 million cubic yards (cys) of dredged material would be removed from the navigation channel as part of the tentatively selected LPP improvements project. Approximately 248,000[1] cys of dredged material would be placed within the LZPA located east and south of Horn Island, while the remainder of dredged material would be placed within the Pascagoula ODMDS south of Horn Island. Suitable, sandy material dredged during new work or channel maintenance efforts are placed within the LZPA as a beneficial use of dredged material.

If the Assistant Secretary of the Army for Civil Works approves the Section 204 report, including Federal assumption of maintenance, then the construction of the improvement project would be funded 100 percent by the non-Federal sponsor and the future O&M would be undertaken by the USACE, Mobile District as part of its routine maintenance efforts. The recommended action would result in the following impacts: (1) temporary water quality degradation during dredging and disposal operations, (2) minor loss of benthic dwelling organisms at the dredging and disposal sites, (3) avoidance of

[1] While a more specific number of 247,032 is referenced in the Main Report & Appendices, this number is rounded up for NEPA purposes.

disturbance to motile benthic and pelagic fauna from dredging and disposal operations; 4) increased depth of expanded portion of the Federal navigation channel in Mississippi Sound; 5) a temporary increase in noise from the equipment; 6) a temporary interruption of vessels calling upon the port and recreational vessels in the vicinity; and 7) a temporary reduction in air quality due to exhaust emissions. Most of these described impacts to the environment would be temporary in nature and localized to the vicinity of the project. Prior to future O&M, the USACE, Mobile District would notify mariners and install signs near the project's vicinity to also notify other users of the operations. The USACE, Mobile District would adhere to water quality standards issued by the State of Mississippi, Department of Environmental Quality (MDEQ), Office of Pollution Control (OPC). Should a hopper dredge be utilized, the USACE, Mobile District would adhere to reasonable and prudent measures as identified in the Gulf of Mexico Hopper Dredging Regional Biological Opinion (GRBO), issued November 19, 2003, amended June 24, 2005, and January 9, 2007. Other reasonable and prudent measures that have been identified during the Endangered Species Act (ESA) Section 7 consultation will also be implemented to minimize impacts. Dredging will be conducted in the most efficient manner to reduce dredging times and impacts to sensitive environmental resources. The other 18 alternatives considered are identified in Section 3.7 of the Feasibility Study; however, those alternatives were found to be less effective for the problems identified in the study. The No Action alternative was also evaluated, per the requirements of the National Environmental Policy Act (NEPA) (42 U.S.C. § 4321 et. seq.) and USACE planning regulations. Implementation of the proposed action would aid in two-way traffic for some vessels, better ability to transit during inclement weather conditions, and night use of the navigation channel for some vessels currently restricted to daylight only transit.

Public Comments: Prior to preparation of the Draft Environmental Impact Statement (DEIS), public involvement was conducted through the publishing of a NOI and holding a public scoping meeting on February 25, 2010 in Pascagoula, Mississippi. A 45-day comment period on the DEIS for improvements to Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels and future associated O&M began with the publication of the U.S. Environmental Protection Agency (USEPA) Notice of Availability (NOA) in the FR. The DEIS was published in the FR on May 30, 2014. A public hearing to discuss and receive comments on the DEIS was held in Pascagoula, Mississippi on July 8, 2014. Individuals and agencies were invited to submit written comments relevant to the DEIS or request to be placed on the mailing list for announcements and for the FEIS by sending the information to Ms. Jennifer L. Jacobson at the address above. The comments received during the comment period were considered in the preparation of the FEIS.

Executive Summary

Project Overview

The Feasibility Report documents whether the proposed channel widening to be constructed by a non-Federal interest is economically justified, environmentally acceptable and consistent with Title II of the Water Resources and Development Act (WRDA) of 1986 [Public Law (Pub. L.) 99-662; 33 U.S.C. § 2232, as amended] (WRDA 1986) and therefore eligible for Federal maintenance under the provisions of Section 204(f).

The JCPA requested the USACE conduct a Feasibility Study of the Bayou Casotte Harbor Channel Improvement Project in the fall of 2008. This study was conducted under authority of Section 204 of the WRDA 1986. The Feasibility Study was initiated on January 6, 2010, upon receipt of non-Federal funding and execution of the Support Agreement (Agreement No. JCPA0001) between the USACE, Mobile District and the JCPA. The USACE published a NOI in the FR, Volume 75, Number 23, on Thursday, February 4, 2010. The NOI announced USACE's intention to prepare a DEIS to address the potential impacts associated with improving Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels of the Federal navigation channel project and its associated future O&M in Jackson County, Mississippi.

The USACE, Mobile District prepared this FEIS to assess the potential impacts (i.e. environmental and socio-economic) associated with the improvements to Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels located in Jackson County, Mississippi and associated future O&M. Many of the existing project features were provided for by the River and Harbor Act, which was approved on October 23, 1962 (House Document [H.D.] Number 560, 87th Congress). Construction of the Federal project commenced in 1962 and was completed in 1965 (USACE, 1985a). Improvements to the Pascagoula Harbor Navigation Channel were evaluated in the *Pascagoula Harbor, Mississippi, Feasibility Report* (USACE, 1985a). The USACE completed a FEIS in 1985 and improvements to the Pascagoula Harbor Navigation Channel were authorized by the WRDA of 1986. Subsequent to this authorization, an EIS for the designation of an ODMDS located offshore of Pascagoula was completed in 1991. The Record of Decision (ROD) for the improvements to the Pascagoula Harbor Navigation Channel was signed in July 24, 1992. A Final Supplemental Environmental Impact Statement (FSEIS) was prepared in August 2010 to update the FEIS, published in July 1985, which evaluated the potential for widening and deepening channels associated with the federally authorized Pascagoula Harbor (USACE, 1985a; USACE, 1985b; USACE, 2010). Construction of all phases of the improvements was completed by 2016, except for: deepening the Horn Island impoundment basin to 56 feet.

Alternatives evaluated for the present Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels project as shown in Figure S-1 include the No Action and widening the Lower Pascagoula Channel and Bayou Casotte Channel by 50-foot increments to a total width of 150 feet on one side or 75 feet on both sides of the channel. Inclusion or exclusion of a bend easing is also evaluated. Nineteen (19) alternatives have been identified and evaluated in this FEIS, including the No Action Alternative.

Figure S-1
Port of Pascagoula Aerial Channel Segments

Bayou Casotte Harbor Channel Improvement Project FEIS Study Sponsor

The JCPA is the non-Federal sponsor for the existing Federal navigation project for Pascagoula Harbor, Mississippi, and for this Feasibility Study of the Bayou Casotte Harbor Channel Improvement Project. The JCPA, officially organized in 1956, began as an outgrowth of a campaign by the Jackson County Board of Supervisors (JCBOS) to accelerate industrial development.

The Port of Pascagoula ("the Port") is Mississippi's largest port in terms of annual water-borne tonnage and it also serves as the center of the state's fishing industry. The Port has two harbors (Pascagoula River Harbor and Bayou Casotte Harbor) consisting of eleven public and private terminals which move in excess of 35 million tons of cargo through the channels annually.

Study Authority

This study was conducted pursuant to Section 204 of the WRDA 1986. Section 204(a) authorizes the non-Federal sponsor to undertake navigational improvements; Section 204(b) authorizes the USACE to undertake all necessary studies and engineering for construction and provide technical assistance in obtaining necessary permits; and Section 204(f) directs the Government to assume responsibility for maintenance of such improvements, if (1) Prior to construction of the improvements the Secretary determines the improvements are economically justified, environmentally acceptable and are consistent with the purposes of Title II of WRDA 1986; (2) the Secretary certifies that the project is constructed in accordance with applicable permits and appropriate engineering and design standards; and (3) the Secretary does not find the project or element is no longer economically justified or environmentally acceptable.

No private, public, tribal, or other Federal entity may temporarily or permanently occupy, use, or alter an USACE authorized Federal project without receiving a permit issued by the USACE. The authority to issue such permits is contained in 33 USC § 408 (Section 408), titled *Taking possession of, use of, or injury to harbor or river improvements*, and states the following – "*It shall not be lawful for any person or persons to take possession of or make use of for any purpose, or build upon, alter, deface, destroy, move, injure, obstruct by fastening vessels thereto or otherwise, or in any manner whatever impair the usefulness of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States, or any piece of plant, floating or otherwise, used in the construction of such work under the control of the United States, in whole or in part, for the preservation and improvement of any of its navigable waters or to prevent floods, or as boundary marks, tide gauges, surveying stations, buoys, or other established marks, nor remove for ballast or other purposes any stone or other material composing such works: Provided, That the Secretary of the Army may, on the recommendation of the Chief of Engineers, grant permission for the temporary occupation or use of any of the aforementioned public works when in his judgment such occupation or use will not be injurious to the public interest: Provided further, That the Secretary may, on the recommendation of the Chief of Engineers, grant permission for the alteration or permanent occupation or use of any of the aforementioned public works when in the judgment of the Secretary such occupation or use will not be injurious to the public interest and will not impair the usefulness of such work."*

Planning Opportunities

The USACE determined that changes were required in the existing Federal navigation project (study area) to provide for the following:

- Reduce the transportation cost of import and export trade through Bayou Casotte Harbor and contribute to increases in national net income;
- Provide a more accessible channel and increased opportunities for vessel transit;

- Provide improved conditions for vessel operation;
- Reduce constraints of harbor pilot operating practices;
- Maintain natural resources within the project area;
- Provide beneficial placement of dredged material (e.g., in the LZPA); and
- Contribute to the preservation of historically significant resources in the project area.

Management measures are single features or activities that address a study's planning objectives. Plans (alternatives) are combinations of one or more measures. The preliminary list of planning measures identified for the Bayou Casotte Harbor Channel Improvement Project follow. As shown, both structural and non-structural measures were considered.

- No Action
- Channel Widening
- Bend Easing
- Alternate Vessel Speeds
- Navigation Aids
- Tug Assist
- Harbor Control System

Non-Structural Measures:

1. **No Action**: The USACE is required to consider the option of "No Action" as one of the study alternatives in order to comply with the requirements of NEPA. With the No Action Plan (i.e., the Without Project Condition), it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. However, normal O&M activities are assumed to be performed over the period of analysis. The No Action Plan, therefore, forms the basis to which all other alternative plans are measured.

2. **Alternate Vessel Speeds**: Alternate vessel speeds were considered for their ability to help reduce and/or eliminate any of the identified study problems. In particular, this measure was considered for its ability to reduce harbor congestion or increase vessel maneuverability during inclement weather.

3. **Navigation Aids**: Aids to navigation are the markers and signals vessels required to safely use a navigation project (USACE, 2006a). The navigation safety of a project is directly related to the clarity and visibility of aids to navigation. Channel design must be planned so that the layout, dimensions, and alignment facilitate clear marking. A reduced width may be possible in a well-marked channel as compared to a poorly marked channel, so a tradeoff between channel widening cost and aids to navigation cost should be considered in design.

4. **Tug Assist**: A tug is a boat that maneuvers vessels by pushing or towing them. Tugs move vessels that either should not move themselves, such as ships in a crowded harbor or a narrow canal, or those that cannot move by themselves, such as barges, disabled ships, or oil platforms. Tugboats are powerful for their size and strongly built, and some are ocean-going. Tugboat engines typically produce between 680 to 3,400 horsepower (hp), but larger boats (used in deep waters) can have power ratings up to 27,200 hp and usually have an extreme power:tonnage-ratio. Tugboats are highly maneuverable, and various propulsion systems have been developed to increase maneuverability and increase safety. Additional tug assistance was considered for its ability to help increase vessel maneuverability and resultant safety and/or reduce harbor congestion. Tug assist was also considered as a complement to other study measures.

5. **Harbor Control System:** Modification of the existing traffic management system utilized by the port was identified as a non-structural measure that might help to reduce harbor congestion and increase vessel operating efficiencies. The traffic management system currently employed

by the Port of Pascagoula and Pascagoula Bar Pilots Association includes active scheduling and traffic management by the port's Harbormaster, as well as ship to ship, and ship to dispatch communication via radio/telephone as ships traverse the harbor. Each Pilot is in contact with the Harbormaster, dispatcher, other shipboard Pilots, and other (inland) marine traffic as they pilot vessels into and out of the harbor. Vessel scheduling is coordinated by the Harbormaster who takes into consideration traffic volumes, transit restrictions/limitations for particular vessels, allocation of tug/pilot assets, current and forecast weather conditions, and industry need.

Structural Measures:

1. **Channel Widening:** This measure consists of numerous channel widening options for the Lower Pascagoula and Bayou Casotte Channels, including widening the Lower Pascagoula Channel and Bayou Casotte Channel by 50-foot increments to a total width of 150 feet on one side or 75 feet on both sides of the channel, with disposal of dredged material using one of several methods and locations and conducting future maintenance dredging and placement as scheduled. The JCPA indicated its desired channel width when first approaching the USACE about performing the study. However, in an effort to evaluate the full range of impacts and determine the optimal project design, incremental channel widening of 50, 100 and 150 feet were considered as well as alternate locations for widening efforts (i.e., to the west, east and both sides of the channel).

Table 0-1: Structural Measures – Channel Widening

Structural Measure	Description
1	50-foot widening on West Side of Channel
2	100-foot widening on West Side of Channel
3	150-foot widening on West Side of Channel
4	50-foot widening on East Side of Channel
5	100-foot widening on East Side of Channel
6	150-foot widening on East Side of Channel
7	25-foot widening on Both Sides of Channel
8	50-foot widening on Both Sides of Channel
9	75-foot widening on Both Sides of Channel

2. **Bend Easing:** During the planning process, it became apparent that bend easing between the Horn Island Pass and the Lower Pascagoula Channel would assist in vessel transition between those channel segments. Therefore, at the request of the JCPA, this structural feature was also evaluated.

Alternative Plans:

The final array of alternatives evaluated to address the identified study problems are shown in the following table. Alternatives include the No Action Plan-Alternative A, and eighteen structural alternatives, Alternatives 1 through 18. Each of the eighteen alternatives include incremental widening of both the Lower Pascagoula and Bayou Casotte Channels (i.e., by 50 feet, 100 feet and 150 feet). Alternatives 1-3 and 10-12 address channel widening on the west side of the channel, with the latter

three alternatives including easing at the transition between the Horn Island Pass and the Lower Pascagoula Channel. Alternatives 4-6 and 13-15 include channel widening on the east side of the existing channel segments with bend easing for Alternatives 13-15. Lastly, Alternatives 7-9 and 16-18 include incremental widening on both sides of the channel, with bend easing included in Alternatives 16-18. Improved channel lengths are parallel to the centerline of the channel and vary from 6.01 miles to 7.22 miles in length. Similar to the existing condition, one on five channel side slopes were used for with project conditions.

Table 0-2: Project Alternatives

Alternative	Description
A	No Action, Without Project Condition
1	50-foot widening on West Side of Channel
2	100-foot widening on West Side of Channel
3	150-foot widening on West Side of Channel
4	50-foot widening on East Side of Channel
5	100-foot widening on East Side of Channel
6	150-foot widening on East Side of Channel
7	25-foot widening on Both Sides of Channel
8	50-foot widening on Both Sides of Channel
9	75-foot widening on Both Sides of Channel
10	50-foot widening on West Side of Channel w/Bend Easing
11	100-foot widening on West Side of Channel w/Bend Easing
12	150-foot widening on West Side of Channel w/Bend Easing
13	50-foot widening on East Side of Channel w/Bend Easing
14	100-foot widening on East Side of Channel w/Bend Easing
15	150-foot widening on East Side of Channel w/Bend Easing
16	25-foot widening on Both Sides of Channel w/Bend Easing
17	50-foot widening on Both Sides of Channel w/Bend Easing
18	75-foot widening on Both Sides of Channel w/Bend Easing

Disposal Alternatives:

1. **Upland Disposal Site(s):** Two existing upland disposal sites, Triple Barrel and Bayou Casotte Dredged Material Management Site (BCDMMS), accommodate material dredged from the Federal navigation project. Other upland disposal sites were also evaluated as potential dredged material disposal sites.

2. **Open-water Disposal Site(s):** Previously designated open-water sites adjacent to the channel consist of open-water sites 3 and 4 to the east of Bayou Casotte channel and 5, 6, 7, 8, and 9 to the west of the Lower Pascagoula channel.

3. **Littoral Zone Placement Area:** Sandy material dredged from the Horn Island Pass is typically placed within this site along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential to the downdrift barrier islands.

4. **Ocean Disposal Site:** The Pascagoula ODMDS is located within the area surrounded by Horn Island to the north, the Pascagoula Ship channel to the east, the navigation safety fairway to the south, and a north-south line running through Dog Keys Pass to the west. The Pascagoula ODMDS encompasses an area of approximately 24.3 square nautical miles (nm) ranging in depth from about 30 feet in the north to over 60 feet in the southern section. The center coordinate for the site is 30°10'09"N and 88°39'12"W. The boundary coordinates of the Pascagoula ODMDS are North American Datum (NAD) 27:

30°12’06” N	88°44’30” W
30°11’42” N	88°33’24” W
30°08’30” N	88°37’00” W
30°08’18” N	88°41”54” W

5. **Beneficial Use:** Beneficial use sites considered for placement of new work and future O&M material dredged from within the navigation channel included Greenwood Island Semi-Confined site located south of Greenwood Island in Mississippi Sound, Singing River Island (SRI) Semi-Confined site, the previously discussed LZPA, Round Island Beneficial Use Site, Grand Batture Island located in Grand Bay, Mississippi, and other future potential beneficial use site(s) that may be constructed by the time of construction and/or future O&M.

Public Involvement and Agency Coordination

The 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 USACE, Mobile District has made every diligent effort to involve the public in any public meetings, such as scoping and workshops. Other methods used to reach the general public and interested stakeholders included meeting announcements, news releases to local print media, and a web site. Further public communications included maintaining contact with public officials and agency representatives and ensuring that calls from the public were addressed in a timely manner. In addition, the FEIS will be widely circulated.

Public involvement materials are located in *Appendix A: Public Involvement* of this FEIS. These materials include copies of the public involvement management strategy (PIMS), NOI, NOA, public notices for the scoping and workshop meeting(s), and copies of correspondence directed to and received from cooperating state and Federal agencies. The USACE published a NOI in the FR, Volume 75, Number 23, on February 4, 2010 and had a public scoping meeting on February 25, 2010. The USACE published a NOA in the FR, Volume 79, Number 104, on May 30, 2014 and held a public workshop on July 8, 2014. Comments received from the meeting(s) and the NOA were incorporated into this FEIS. Please reference *Appendix C: Agency Correspondence* of this FEIS and USACE responses. Coordination topics are summarized in Table S-1.

Table S-1
Summary of Public, State, and Federal Coordination

Agency	Nature of Correspondence
MDEQ	Review and comment on DEIS and FEIS Water quality certification (WQC)
Mississippi Department of Marine Resources (MDMR)	Review and comment on DEIS and FEIS Consistency determination under coastal zone management program
National Marine Fisheries Service (NMFS), Protective Resource Division (PRD) and Habitat Conservation Division (HCD)	Review and comment on DEIS and FEIS Endangered species (Section 7) consultation Essential fish habitat (EFH) consultation
U.S. Department of the Interior (USDOI)	Review and comment on DEIS and FEIS
USEPA	Review and comment on DEIS and FEIS
U.S. Fish and Wildlife Service (USFWS)	Review and comment on DEIS and FEIS Endangered species (Section 7) consultation
Mississippi Department of Archives and History (MDAH)	Review and comment on DEIS and FEIS Cultural Resources (Section 106) consultation

Source: USACE.

Participation in scoping was encouraged through a public scoping meeting announcement to Federal, state, and local agencies, environmental groups, and interested individuals. In addition, participation in public scoping was also encouraged through posting on the USACE web page and in the local newspaper. The scoping meeting announcement is located in *Appendix A: Public Involvement* of this FEIS. The meeting announced the commencement of the EIS process and was used to gather initial public concerns and issues. The USACE presented background information on the project and its purpose, the area of study, and the possible options available. At the scoping meeting, the public was given an opportunity to ask questions and make comments concerning the project. A court reporter was present and transcribed the meeting. A summary of the results and comments received at the public scoping meeting was prepared and a copy of the meeting transcript is included in *Appendix A: Public Involvement*.

In addition, there were separate meetings held to gather information on the widening effort with Federal, state, and local agencies, environmental groups, and interested individuals as part of the NEPA process. Meetings included telephone discussions with resource agencies and monthly user group meetings with industry, all in the greater Pascagoula area.

A public workshop was held on July 8, 2014 to present findings from the EIS and to receive public comments. The public workshop is an opportunity for the public to understand the proposed project. A public notice was sent to interested stakeholders and the general public mailing list 30 days prior to the public workshop. A legal notice was published in the Sun Herald on June 20, July 3 and July 10, 2014. The workshop announcement was also posted on the USACE web site. During the workshop, the USACE presented the need for the project, study authority, the alternatives evaluated, and the proposed project. A court reporter was present to transcribe any verbal public comments submitted at the meeting. A public workshop summary was prepared summarizing the results and comments received at the public meeting. A copy of the meeting transcript is included in the *Appendix A: Public Involvement* of this FEIS. The public workshop summary is included in the FEIS.

Major Conclusions and Findings

Environmental and socioeconomic effects from implementing the proposed action or any of the other alternatives were evaluated to determine all potential human and natural consequences. Alternatives evaluated (i.e. the No Action or varying project dimension widths) all include dredging with mechanical, hydraulic pipeline, and/or hopper equipment and the subsequent placement of that material within existing open-water, littoral, beneficial use, and/or ocean disposal site(s). Differences among these alternatives vary only by 50-foot width increments to a total of 150-foot (i.e. up to 75-foot on both sides, or 150-foot to the west or east).

The No Action Alternative would result in continued O&M dredging of the 42-foot deep by 350-foot wide federally authorized navigation channel (plus 2-foot of advanced maintenance, plus 2-foot of overdepth dredging and plus 3-foot of sediment disturbance depth) with subsequent placement within open-water sites adjacent to the navigation channel, LZPA, and/or ocean sites. Improvements to the navigation project would also include dredging and subsequent placement of that material within the same disposal sites with only minor differences, such as increased quantities of material [i.e. approximately 2,160,000 cys for only O&M with the No Action (see Table 3-10 of the Main Report) to approximately 3,604,064 cys for new work (see Table 3-9 of the Main Report) plus approximately 2,679,000 cys for O&M for Alternative 11 (see Table 3-10 of the Main Report] and expanding beyond the historically dredged footprint [up to 129 acres].

Impacts typically associated with the use of a dredge (hopper, mechanical or hydraulic) include: 1) temporary water quality degradation during operations; 2) minor loss of bottom dwelling organisms; 3) avoidance of the operation area by pelagic and benthic fauna; 4) a temporary reduction in aesthetics; 5) a change in bathymetry (i.e. increased channel dimensions and reduced depth at placement sites) and 6) a temporary reduction in air quality due to exhaust emissions. Very dynamic coastal processes in Mississippi Sound result in increased shoaling rates and sediment movement due to the Sound's shallow depth. Listed threatened or endangered species protected under the ESA would likely avoid the area during operations. Protective measures identified during the coordination will be implemented should a hopper dredge be utilized. Implementation of those reasonable and prudent measures would minimize impacts to the listed species. These described impacts are minor and insignificant impacts that are typical of these operations.

Area(s) of Concern

Widening of Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels and the future O&M is anticipated to result in direct, indirect and cumulative effects throughout the project area. Determining the extent to which the improvements and future O&M of the navigation channel contributes to these impacts and what, if any, actions would be necessary to remediate any such impacts are necessary. Areas of concern identified included sediment transport, hydrodynamic, and water quality alterations which could ultimately raise concerns for Gulf Sturgeon Critical Habitat (GSCH) modification. The Engineer Research and Development Center (ERDC) conducted sediment transport, hydrodynamic, and water quality modeling of Mississippi Sound for the purpose of evaluating impacts associated with the proposed widening of the Bayou Casotte and the Lower Pascagoula Federal navigation channels (*Appendix B – ERDC Water Quality Modeling Reports* of this FEIS).

The improvements project would deepen (as associated with the widening action) current GSCH along the westward side of the navigation channel from variable natural depths (-9 to -13 feet) to an overall depth of -46 feet mean lower low water (MLLW). Future O&M of this improved portion adjacent to the existing navigation channel would continue to be maintained to -46 feet deep. This widening project encompasses approximately 87.6 acres of GSCH within Mississippi Sound. These open-water disposal areas proposed for future O&M material placement within GSCH include open-water sites 3,

4, 5, 6, 7, 8, and 9 (approximately 7,450 acres) and the LZPA (approximately 1,736 acres). Mississippi Sound is a shallow water environment heavily influenced by wave action, tidal flux, and frequent climatic events, such as routine storms to strong hurricanes; thus, it along with these disposal sites are in a constant state of flux. Furthermore, use of these sites for O&M activities occurs only about every 12-18 months. NMFS ultimately concluded that the proposed action is not likely to destroy or adversely modify designated GSCH in their Biological Opinion issued on November 4, 2015.

The study was on hold for several years (June 2013 – November 2015) pending receipt of the Biological Opinion from NMFS. When the study pause began, the report was at a final draft stage (i.e., alternative comparison had concluded and a tentatively selected plan had been identified). Once study efforts resumed, updates were made to those data/analyses that could potentially impact project optimization and plan selection (e.g., empirical commodity and fleet data); however, data/analyses that did not warrant additional efforts were not updated. Source, date, and fiscal year citations have been provided throughout the document for transparency.

Unresolved Issues

All known issues have been addressed by the USACE, Mobile District in this FEIS.

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GLOSSARY OF TERMS

ACHP	Advisory Council for Historic Preservation
APE	Area of Potential Effect
ARPA	Archaeological Resources Protection Act
ARRA	American Recovery and Reinvestment Act
ATONS	Aids to Navigation
AWOIS	Automated Wreck and Obstruction Information System
BAs	Biological Assessments
BCDMMS	Bayou Casotte Dredged Material Management Site
BGEPA	Bald and Golden Eagle Protection Act
BOEM	Bureau of Ocean Energy Management
°C	Celsius
CAA	Clean Air Act
CBRA	Coastal Barrier Resources Act
CEQ	Council on Environmental Quality
CFR	Code of Federal Regulations
cfs	cubic feet per second
cm^3/L	cubic centimeters
CO	Carbon monoxide
CO_2	Carbon dioxide
CWA	Clean Water Act
cys	cubic yards
CZMA	Coastal Zone Management Act
DAP	Diammonium phosphate
dBa	decibels
DEIS	Draft Environmental Impact Statement
DMMA	Dredged material management area

DMMP	Dredged material management plan
DMMS	Dredged material management site
DO	Dissolved oxygen
DWT	Deadweight tons
EA	Environmental Assessment
EC	Engineering Circular
EC50	Effective Sub-Lethal Concentration
EEZ	Exclusive Economic Zone
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EJ	Environmental Justice
ELMR	Estuarine Living Marine Resources
EO	Executive Order
EOR	Enhanced Oil Recovery
EQ	Environmental Quality
ER	Engineering Regulation
ERDC	Engineering Research and Development Center
ESA	Endangered Species Act
ESRI	Environmental Systems Research Institute
ft	Feet
F	Fahrenheit
FCCE	Flood Control and Coastal Emergencies
FEIS	Final Environmental Impact Statement
FEMA	Federal Emergency Management Agency
FERC	Federal Energy Regulatory Commission
FMCs	Fishery Management Councils
FMPs	Fishery Management Plans
FONSI	Finding of No Significant Impact

FR	Federal Register
FSEIS	Final Supplemental Environmental Impact Statement
FUSRAP	Formally Utilized Sites Remedial Action Program
FWCA	Fish & Wildlife Coordination Act
GBNWR	Grand Bay National Wildlife Refuge
GEMS	Gulf Ecological Management Site
GINS	Gulf Islands National Seashore
GIWW	Gulf Intracoastal Waterways
GMFMC	Gulf States Marine Fisheries Commission
GRBO	Gulf Region Biological Opinion
GRP	Gross Regional Product
GSCH	Gulf Sturgeon Critical Habitat
HAB	Harmful Algal Blooms
H.D.	House Document
HCD	Habitat Conservation Division
HMS	Highly Migratory Species
hp	horsepower
HpCDD	Heptachlorodibenzo-para-dioxin
IMMS	Institute for Marine Mammals Studies
JCBOS	Jackson County Board of Supervisors
JCPA	Jackson County Port Authority
KCS	Kansas City Southern
lb/Mgal	pounds per million gallons
LASH	Lighter Aboard Ship
LC50s	Median Lethal Concentration
LNG	Liquefied Natural Gas
LOA	Length overall
LPC	Limiting Permissible Concentration

LPC	Local Purchase Coefficient
LPP	Locally Preferred Plan
LZPA	Littoral Zone Placement Area
µPa	Micropascal
m^2	Square meters
MDAH	Mississippi Department of Archives and History
MDEQ	Mississippi Department of Environmental Quality
MDL	Method Detection Limit
MDMR	Mississippi Department of Marine Resources
MDOT	Mississippi Department of Transportation
MDWFP	Mississippi Department of Wildlife Fisheries, and Parks
MFCMA	Magnuson Fishery Conservation and Management Act
MG	Mississippi Gasification
mg/L	milligrams per liter
mg/m^3	milligrams per cubic meter
mg/m^2	milligrams per meter squared
MHW	Mean high water
MLLW	Mean lower low water
MLW	Mean low water
MMPA	Marine Mammal Protection Act
MMS	Minerals Management Services
MOA	Memorandum of Agreement
MOU	Memorandum of Understanding
MPC	Mississippi Phosphates Corporation
MPRSA	Marine Protection, Research, and Sanctuaries Act
MS	Mississippi
MsCIP	Mississippi Coastal Improvements Program
MSCNWR	Mississippi Sandhill Crane National Wildlife Refuge

MS MNR	Mississippi Museum of Natural Resources
MS MNS	Mississippi Museum of Natural Science
MS SOS	Mississippi Secretary of State
MSU	Mississippi State University
NAAQS	National Ambient Air Quality Standards
NAD	North American Datum
NASA	National Aeronautics and Space Administration
NCA	National Coastal Assessment
ND	Non-detect
NED	National Economic Development
NEPA	National Environmental Policy Act
NER	National Ecosystem Restoration
NERR	National Estuarine Research Reserve
NFWF	National Fish & Wildlife Foundation
NGOs	Non-Governmental Organizations
NHPA	National Historic Preservation Act
nm	Nautical miles
NMFS	National Marine Fisheries Service
NOA	Notice of Availability
NOAA	National Oceanic and Atmospheric Administration
NOI	Notice of Intent
NO_x	Nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRHP	National Register of Historic Places
NTU	Nephelometric Turbidity Unit
NWPs	Nationwide Permits
O&M	Operation and Maintenance

OCDD	Octachlorodioxin
OCRM	Office of Ocean and Coastal Resource Management
ODMDS	Ocean Dredged Material Management Site
OPC	Office of Pollution Control
OSE	Other Social Effects
PAHs	Polycyclic Aromatic Hydrocarbons
PCBs	Polychlorinated Biphenyls
PCEs	Primary Constituent Elements
PBOP	Pascagoula Base Oil Project
PD	Preliminary Draft
PD-EC	Planning Division- Coastal Environment Team
PDT	Project Delivery Team
PEL	Probable effect level
P&G	Principles and Guidelines
PIMS	Public Involvement Management Strategy
Pub. L.	Public Law
PM	Particulate matter
ppm	Part per million
ppt	Part per thousand
PRD	Protected Resources Division
PWSA	Ports and Waterways Safety Act
PTS	Permanent Threshold Shift
PTSA	Port and Tanker Safety Act of 1978
RCRA	Resource Conservation and Recovery Act
RECONs	Regional Economic System
RED	Regional Economic Development
RL	Reporting Limit
ROD	Record of Decision
RPCs	Regional Purchase Coefficients

RSM	Regional Sediment Management
SAV	Submerged Aquatic Vegetation
SCV	Submerged Combustion Vaporizers
SEM/AVS	Simultaneously-Extracted Metals/Acid Volatile Sulfide
SHPO	State Historic Preservation Officer
SIPs	State Implementation Plans
SMA	Special Management Area
SMMP	Site Management Monitoring Plan
SO_x	Sulfur oxides
SQGs	Sediment Quality Guidelines
SRI	Singing River Island
STFATE	Short-Term Fate of Dredged Material
SVOCs	Semi-volatile Organic Compounds
T&E	Threatened and Endangered
TCDD	Tetrachlorodibenzo-p-dioxin
TEDs	Turtle Excluder Device
TEF	Toxicity Equivalency Factors
TEL	Threshold effect level
TEQs	Total Equivalent
TEUs	Twenty-foot equivalent units
TMDL	Total Maximum Daily Load
TMMSN	Texas Marine Mammal Stranding Network
TNC	The Nature Conservancy
TOG	Total organic gases
TSCA	Toxic Substances Control Act
TSS	Total suspended solids
TTS	Temporary threshold shift
UCLM	Upper Confidence Level of the Mean

U.S.	United States
UD	University of Delaware
URI	University of Rhode Island
USACE	U.S. Army Corps of Engineers
USCG	U.S. Coast Guard
USDA	U.S. Department of Agriculture
USDOC	U.S. Department of Commerce
USDOE	U.S. Department of Energy
USDOI	U.S. Department of Interior
USEPA	U.S. Environmental Protection Agency
USFDA	U.S. Food and Drug Administration
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
USM	University of Southern Mississippi
VT	Vision Technologies
WQC	Water Quality Certification
WRDA	Water Resources Development Act

1 INTRODUCTION

The Port of Pascagoula, one of two deep draft commercial harbors in Mississippi, is located in Jackson County, approximately 40 miles west of Mobile, Alabama, and 100 miles east of New Orleans, Louisiana. Deep draft harbor facilities have been developed at two locations within the Port: Pascagoula River Harbor and Bayou Casotte Harbor. The channel serving the Port of Pascagoula extends from the Gulf of Mexico through Horn Island Pass (located between Horn Island and Petit Bois Island) and into Mississippi Sound (Figure S-1). The channel proceeds northward and intersects the Gulf Intracoastal Waterway (GIWW). Just north of the GIWW the channel forks, with the western fork leading to the Pascagoula River Harbor and the eastern fork leading to the Bayou Casotte Harbor.

The USACE, Mobile District prepared this FEIS to analyze potential environmental consequences of improvements to the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels and associated future O&M.

1.1 Authorization

The study is being conducted under authority of Section 204 of the WRDA 1986. Section 204(a) authorizes the non-Federal sponsor to undertake navigational improvements; Section 204(b) authorizes the USACE to undertake all necessary studies and engineering for construction and provide technical assistance in obtaining necessary permits; and Section 204(f) directs the Government to assume responsibility for maintenance of such improvements, if (1) Prior to construction of the improvements the Secretary determines the improvements are economically justified, environmentally acceptable and are consistent with the purposes of Title II of WRDA 1986; (2) the Secretary certifies that the project is constructed in accordance with applicable permits and appropriate engineering and design standards; and (3) the Secretary does not find the project or element is no longer economically justified or environmentally acceptable. The study was initiated in January 2010 upon receipt of non-Federal funding and execution of the Support Agreement between the USACE, Mobile District and the JCPA.

No private, public, tribal, or other Federal entity may temporarily or permanently occupy, use, or alter an USACE authorized Federal project without receiving a permit issued by the USACE. The authority to issue such permits is contained in 33 USC § 408 (Section 408), titled *Taking possession of, use of, or injury to harbor or river improvements*, and states the following – "*It shall not be lawful for any person or persons to take possession of or make use of for any purpose, or build upon, alter, deface, destroy, move, injure, obstruct by fastening vessels thereto or otherwise, or in any manner whatever impair the usefulness of any sea wall, bulkhead, jetty, dike, levee, wharf, pier, or other work built by the United States, or any piece of plant, floating or otherwise, used in the construction of such work under the control of the United States, in whole or in part, for the preservation and improvement of any of its navigable waters or to prevent floods, or as boundary marks, tide gauges, surveying stations, buoys, or other established marks, nor remove for ballast or other purposes any stone or other material composing such works: Provided, That the Secretary of the Army may, on the recommendation of the Chief of Engineers, grant permission for the temporary occupation or use of any of the aforementioned public works when in his judgment such occupation or use will not be injurious to the public interest: Provided further, That the Secretary may, on the recommendation of the Chief of Engineers, grant permission for the alteration or permanent occupation or use of any of the aforementioned public works when in the judgment of the Secretary such occupation or use will not be injurious to the public interest and will not impair the usefulness of such work."*

1.1.1 Regulatory Action

The USACE, Mobile District's Regulatory Division issued a Department of Army permit to the JCPA on November 28, 2012, under Section 404 of the Clean Water Act (CWA) (33 U.S.C. §1251 et seq., 1972), Section 10 of the Rivers and Harbors Act of 1899, and Section 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972. A joint Public Notice for the permit application (SAM-2011-00389-PAH) was issued by the USACE, Mobile District, Regulatory Division on April 15, 2011. Based on the permit application, the USACE, Mobile District's Regulatory Division determined that the permitting action for the proposed dredge and fill activities constitutes a major Federal action. In accordance with NEPA, an EIS was prepared to analyze and disclose the potential impacts of the proposed project and associated reasonable alternatives on the natural and human environment. The USACE, Mobile District's Regulatory Division is the lead Federal agency for the preparation of that EIS. The action requires compliance with Section 404 of the CWA for the discharge of dredged or fill material into waters of the U.S., including a Section 404(b)(1) analysis to help ensure compliance. The *EIS for the Proposed Widening of the Pascagoula Lower Sound/Bayou Casotte Channel, Jackson County, Mississippi*, released in May 2012, was prepared in support of the regulatory process for the specific permit application and proposed project. The EIS evaluates potential impacts on the human environment from proposed channel widening activities and the placement of dredged material in the Pascagoula ODMDS and the designated LZPA that could be suitable for beneficial use.

The USACE Regulatory *Proposed Widening of the Pascagoula Lower Sound/Bayou Casotte Channel, Jackson County, Mississippi* EIS evaluates environmental impacts anticipated from the non-Federal construction of the project. The USACE, Mobile District, Planning and Environmental Division prepared this separate Civil Works FEIS to evaluate environmental consequences associated with improvements to Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels and associated future maintenance of that navigation project. A Feasibility Study, also prepared by USACE, Mobile District, Planning and Environmental Division, determines if there is sufficient Federal interest to assume future maintenance of the non-Federal sponsor's channel improvements (i.e. widened 100 feet to the west for approximately 7.2 statute miles including bend easing north of Horn Island Pass).

1.1.2 Authorized Project

The Federal navigation project at the Port of Pascagoula has been constructed at different intervals over the past 100 years. Many of the existing project features were authorized in 1962. However, Section 202 (a) of the WRDA 1986 and subsequent harbor documents provided for additional modifications to the Federal navigation project at the Port. The features of the authorized project are provided below (See Figure S-1).

- A Gulf Entrance Channel 44 feet deep and 550 feet wide from the 44-foot depth contour in the Gulf of Mexico to the bend at the southern end of the Horn Island Pass;

- A channel 44 feet deep and 600 feet wide through the Horn Island Pass, beginning at the southern bend of the pass and extending to the northern bend for a total distance of approximately 4-1/2 statute miles and westward relocation of the Horn Island Pass reach by approximately 500 feet;

- An impoundment basin within the channel limits of the Horn Island Pass 56 feet deep and 1,500 feet long to facilitate maintenance and as natural conditions warrant future realignment of the Horn Island Pass reach. Modifications to this impoundment basin, recommended in the 1992 General Design Memorandum (*1.4 Prior Studies and Reports*) and subsequently approved, consisted of authorizing two impoundment basins 56 feet deep, one 200 feet wide

and 2,200 feet long and the other 175 feet wide and 4,630 feet long, along the east side of the Gulf Entrance and Horn Island Pass Channels, respectively;

- Lower and Upper Pascagoula Channels 42 feet deep and 350 feet wide from the bend at the northern end of Horn Island Pass, through the Mississippi Sound and into the Pascagoula River, terminating at Mile 1 in the Pascagoula River Harbor, for a total distance of about 10 statute miles;

- A bend 630 feet wide at the mouth of the Pascagoula River;

- A Pascagoula River Harbor Channel 38 feet deep and 350 feet wide from Mile 1 north to the railroad bridge crossing of the Pascagoula River Harbor at Mile 0;

- On the west side of the Pascagoula River, a turning basin 38 feet deep, 2,000 feet long and 950 feet wide (including the channel area), the northern limit of which is 151 feet south of Mile 0;

- A Pascagoula River Channel 22 feet deep and 150 feet wide from the railroad bridge at Pascagoula (Mile 0) north to the mouth of the Escatawpa River (Dog River), then up the Escatawpa River to the Highway 613 Bridge. A channel 12 feet deep and 125 feet wide from the Highway 613 Bridge, via the Robertson and Bounds Lakes, to Mile 6.0 on the Escatawpa River;

- A channel 12 feet deep and 80 feet wide extending 1,500 feet from the 22-foot deep Pascagoula River Channel (north of the railroad and U.S. Highway 90 bridges) to a turning basin in Krebs Lake, then a channel 10 feet deep and 60 feet wide along the south bank of Krebs Lake, terminating at a second turning basin, a distance of 2,700 feet from the first;

- A Bayou Casotte Channel 42 feet deep and 350 feet wide from its junction with the Lower Pascagoula Channel to the northern limit of the northern turning basin in the Bayou Casotte Harbor, for a total distance of about 4.6 miles;

- A turning basin 42 feet deep, 1,150 feet long, and 1,120 feet wide on the west side of the mouth of Bayou Casotte;

- A turning basin 42 feet deep, 1,750 feet long, and 1,000 feet wide at the northern terminus of the Federal project in the Bayou Casotte Harbor;

- Bend easing and widening; and

- Mitigation for the unavoidable loss of four acres of emergent wetlands by restoring six acres of disturbed wetland habitat south of the Greenwood Island DMMS to a more natural emergent nature (mitigation for the Bayou Casotte DMMS).

It is noted that the Lower Pascagoula Channel intersects the GIWW at approximately Mile 9 of the Lower Pascagoula Channel and Mile 104 of the GIWW.

1.1.3 Existing Project

The *existing* Federal project at the Port of Pascagoula provides for numerous segments, as listed below (Figure 1.1.3-1). Note, the “existing” project differs from the “authorized” project (*1.1.2.*

Authorized Project) in that there are project features that have not been constructed to their authorized dimensions (i.e. maximum approved dimensions). The existing project features differing from authorized dimensions within the study area have been italicized.

- A Gulf Entrance Channel 44 feet deep and 550 feet wide from the Gulf of Mexico to the bend at the southern end of the Horn Island Pass, a Horn Island Pass Channel 44 feet deep and 600 feet wide, *and two impoundment basins 44 feet deep, one 200 feet wide and 2,200 feet long and the other 175 feet wide and 4,630 feet long, along the east side of the Gulf Entrance and Horn Island Pass Channels, respectively;*

- A Lower Pascagoula Channel 42 feet deep and 350 feet wide through the Mississippi Sound north to the 'Y' and an Upper Pascagoula Channel 42 feet deep and 350 feet wide from the 'Y' north to the Pascagoula River, terminating at the railroad bridge crossing of the Pascagoula River Harbor at Mile 0;

- On the west side of the Pascagoula River, a turning basin 38 feet deep, 2,000 feet long and 950 feet wide (including the channel area), the northern limit of which is 151 feet south of Mile 0;

- A Pascagoula River Channel 22 feet deep and 150 feet wide from the railroad bridge at Pascagoula (Mile 0) north to the mouth of the Escatawpa River (Dog River), then up the Escatawpa River to the Highway 613 Bridge. A channel 12 feet deep and 125 feet wide from the Highway 613 Bridge, via the Robertson and Bounds Lakes, to Mile 6.0 on the Escatawpa River;

- A channel 12 feet deep and 80 feet wide extending 1,500 feet from the 22-foot deep Pascagoula River Channel (north of the railroad and U.S. Highway 90 bridges) to a turning basin in Krebs Lake, then a channel 10 feet deep and 60 feet wide along the south bank of Krebs Lake, terminating at a second turning basin, a distance of 2,700 feet from the first;

- A Bayou Casotte Channel 42 feet deep and 350 feet wide from its junction with the Lower Pascagoula Channel in the Mississippi Sound to the mouth of Bayou Casotte;

- A channel 42 feet deep and 350 feet wide in the Bayou Casotte Harbor;

- A turning basin at the south end of Bayou Casotte Harbor which is 42 feet deep and has a turning diameter of 1,125 feet (including the channel area) and a northern turning basin about a mile north which is 42 feet deep, 840 feet wide, and 1,750 feet long; and

- A six-acre mitigation area on the tip of Greenwood Island, west of the Bayou Casotte Harbor entrance (mitigation for the Bayou Casotte DMMS).

Figure 1.1.3-1
Features of the Existing Federal Navigation Channel project

1.2 Purpose and Scope Study

The USACE, Mobile District has prepared this FEIS to assess the potential impacts associated with the improvements to the Port of Pascagoula in Jackson County, Mississippi and associated future O&M. This FEIS evaluates potential effects to the environment, both the human and natural environment. Since the last major navigation improvements *to study area* channel segments were completed by the USACE, Mobile District in 2001, Bayou Casotte Harbor has experienced significant growth in vessel traffic and cargo. The 2001 improvements were designed to accommodate traffic projected at that time. Design for inner harbor improvements was based upon that previously established in the 1992 General Design Memorandum, and approved for use in the Bayou Casotte Harbor Extension Project in 1999. The design ships used in the vessel simulation studies included tankers, bulk carriers, liquefied natural gas (LNG), and Lighter Aboard Ship (LASH) vessels that ranged in length from 763 feet to 948 feet, in beam width from 106 feet to 125 feet, and in draft from 34 feet to 47 feet. Since 2001, significant investments have been made at the harbor to include the development of a LNG facility just south of the harbor's mouth. Vessels currently operating and forecast to operate at the harbor are comprised of many of those previously analyzed but will also include a fleet of new LNG vessels not previously anticipated. The new LNG fleet has a length overall (LOA) of 954 feet, a beam width of 142 feet, and a design draft of 39 feet. The existing federally authorized channel dimensions restrict deep-draft vessels to one-way traffic, restrict vessels greater than 700 feet LOA or product tankers with a draft greater than or equal to 36 feet to daylight travel. Under future conditions, LNG traffic would be restricted due to wind and water current conditions.

The purpose of proposed widening improvements is to increase the efficiency of vessel operations by:

- Reducing congestion in the harbor channels;
- Accommodating recent and anticipated growth in cargo and vessel traffic; and
- Improving the efficiency of vessel operations.

Globalization and large increases in commodity trade are significantly increasing shipping demands around the world. Technological advances have accelerated trends towards producing larger ships to meet these economic pressures. The proposed project will reduce existing channel and harbor restrictions, thereby improving operating conditions and efficiency in the channel and harbor.

The mission of the USACE navigation program is to provide safe, reliable, efficient, effective and environmentally sustainable waterborne transportation systems for movement of commerce, national security needs, and recreation. This mission requires that modification plans to USACE constructed navigation projects are compatible with the project's navigation needs and consistent with the requirements of the vessels using that portion of the waterway. Modification plans must also provide a long-term plan for the placement of dredged materials in order to continue maintenance of the waterway in the future. Since the JCPA is seeking to construct modifications to a Federal navigation project and have USACE assume maintenance of the proposed improvements, a study report must be approved by the Secretary before any construction is undertaken. The study report must establish that the proposed work is technically feasible, economically justified and environmentally acceptable as per Engineering Regulation (ER) 1165-2-504. Since the proposed project includes modifying the existing, authorized Federal project, a Section 408 permit is also required. In order to issue a Section 408 permit, a determination must be made that the proposed modification does not impair the usefulness of the Federal project and that it is not injurious to the public interest. Documentation prepared for the Section 204(f) report for the Secretary may also serve as the documentation for the 408 permit request. As such, it is intended that this report will serve both purposes.

1.3 Study Area Location and Geographic Description

The Port of Pascagoula, Bayou Casotte Harbor is located in Jackson County, Mississippi, in the southeastern-most portion of the state in the Gulf of Mexico. It is positioned south of the juncture of Interstate-10 and Mississippi Highway 63. The Port of Pascagoula is accessible from the Gulf of Mexico by a shipping channel located through the pass between Horn Island and Petit Bois Island in Mississippi Sound. The Horn Island Pass sea buoy marks the entrance to this channel at 30º 11 minutes north and 88º 3 minutes west. The channel proceeds northward crossing the GIWW. Just north of the GIWW the channel splits into an eastern and western fork which leads to Bayou Casotte Harbor (Figure 1.3.2-1) and the Pascagoula River Harbor, respectively.

Bayou Casotte Harbor supports both public and private terminals, which are listed below in Section(s) 1.3.1 and 1.3.2.

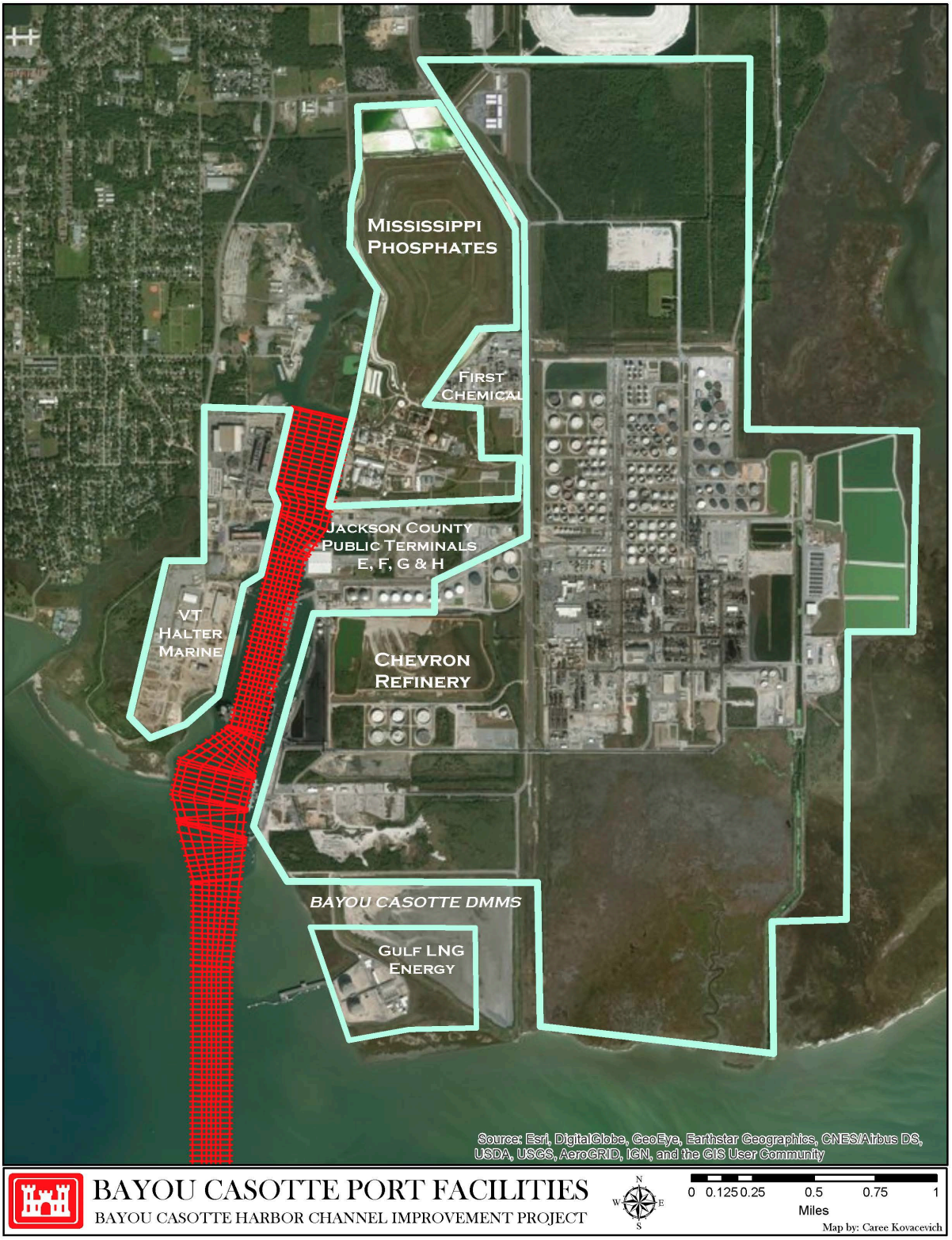
1.3.1 Public Terminals

- Terminal E – 517-foot x 37-foot wharf - 175,000 square foot transit warehouse (shared with Terminal F)
- Terminal F – 737-foot x 55-foot wharf - transit warehouse/marginal rail track
- Terminal G – 516-foot x 60-foot wharf - 175,000 square foot transit warehouse (shared with Terminal G)
- Terminal H – 556-foot x 34-foot wharf - transit warehouse
- Terminal G Extension – Barge Berth 695-foot x 120-foot wharf, 15-foot depth

1.3.2 Private Terminals

- Chevron Pascagoula Refinery (Chevron Shipping Co.)
- Mississippi Phosphates Corporation
- Vision Technologies (VT) Halter Marine
- Gulf LNG Energy, LLC
- First Chemical Corporation
- Enviva Partners, LP

Figure 1.3.2-1
Terminals of Port of Pascagoula- East Bank (Bayou Casotte Harbor)



1.3.2.1 Chevron Pascagoula Refinery

Chevron began operation of its Pascagoula Refinery in 1963, and the refinery has grown to be the corporation's largest U.S. refinery and one of the top ten petroleum refineries in the U.S. Operating around the clock, the Pascagoula Refinery processes 330,000 barrels (1 barrel equal to 42 gallons), or 13.9 million gallons of crude oil per day in the manufacture of petroleum products and chemicals used for many other useful products.

Chevron's facility in Pascagoula is primarily a 'fuels' refinery, in that the refinery's primary products are motor gasoline, jet fuel and diesel fuel. Other products include fuel oils, such as bunker fuel, Liquefied Petroleum Gas, aviation gasoline, petroleum coke and sulfur. In addition, the Chevron facility also manufactures specialty products that include paraxylene, a pure compound used as a feed stock in the textile and plastics industry, and benzene and ethylbenzene, used in the manufacture of a wide range of products including automobile tires, sporting goods, nylon and pharmaceuticals. The refinery's manufacturing, storage and shipping facilities consist of 20 major refining process units, more than 200 tanks (600 million gallons total capacity), and four marine terminals with seven berths.

The Pascagoula Refinery is located east of the City of Pascagoula in an unincorporated area of east Jackson County situated in the Bayou Casotte Industrial Park on over 3,000 acres adjacent to Mississippi Sound. Since only a portion of the property is developed, about two-thirds of the acreage is wetlands and forestlands that are home to nearly all species of wildlife indigenous to the Gulf Coast. The refinery is located on Industrial Road (also called Mississippi Highway 611), just off U.S. Highway 90.

1.3.2.2 Mississippi Phosphates Corporation

Mississippi Phosphates Corporation's production facility is located in Pascagoula, Mississippi. Mississippi Phosphates has the capacity to produce approximately 720,000 tons of diammonium phosphate (DAP) annually based on sulfuric acid produced at the site and approximately 850,000 tons annually, if supplemental sulfuric acid is available for purchase. Two-thirds to three-quarters of this product is sold domestically, with the balance exported, primarily to Latin America. The Company's export sales are marketed through Transammonia, Inc., a major global trading company. Mississippi Phosphates deep-water port facility on the Gulf of Mexico allows the Company to load ships for export directly from the plant site. Domestic sales of DAP are distributed by rail, truck and barge.

In October 2014, the Mississippi Phosphates Corporation filed for Chapter 11 bankruptcy protection; operations ceased at the facility in December 2014. Two trusts were created in 2015 as part of the bankruptcy proceedings: an Environmental Trust and a Liquidation Trust. In October 2015, the Liquidation Trust assumed control and ownership of the operating portions of the former Mississippi Phosphates facility, including the fertilizer production plants, commercial buildings, docks and other marketable real estate. The purpose of the Liquidation Trust is to market and sell portions of the former facility.

1.3.2.3 VT Halter Marine

VT Halter Marine, Inc. is a subsidiary of VT Systems, Inc. that utilizes technologies to design and build the maritime products. VT Halter Marine provides a wide inventory of diversified, high-tech maritime products to U.S. and international markets. VT Halter Marine has the capacity for small to medium size ship construction. VT Halter Marine shipyards have delivered over 3,000 vessels to commercial and government clients in 29 countries on 5 continents. VT Halter Marine, Inc. is a full service shipbuilding company with modern design, engineering, shipbuilding, program management, and

logistics resources. VT Halter Marine builds vessels in steel, aluminum or composites in a variety of hull forms. VT Halter Marine also builds catamarans, trimarans, SWATHS, Surface Effects Ships, Very Slender Vessels and many other hull forms. VT Halter Marine designs and builds to the requirements of the U.S. Coast Guard (USCG), U.S. Navy, American Bureau of Shipping, Lloyds, Det Norske Veritas, IMO and other regulatory bodies and classification societies.

1.3.2.4 Gulf LNG Energy

Gulf LNG Energy, LLC owns and operates Gulf LNG Energy terminal. The terminal will receive, store and re-gasify imported/exported LNG. The terminal comprises two natural gas storage tanks with a combined capacity of 6.6 billion cubic feet, 10 vaporizers and connections to the Gulfstream, Destin, Florida Gas Transmission and Transco pipelines. The company was incorporated in 2007 and is based in Bayou Casotte Harbor, Pascagoula, Mississippi. Gulf LNG Energy, LLC operates as a subsidiary of El Paso Corp. Gulf LNG executed an agreement with the JCPA and Jackson County, Mississippi, (collectively, Port of Pascagoula) regarding the use of land in Bayou Casotte that is controlled by the Port of Pascagoula for the purpose of locating an LNG import/export and re-gasification terminal.

1.3.2.5 First Chemical Corporation

The First Chemical Corporation produces aniline and nitrotoluene intermediates and derivatives. First Chemical Corporation is the world's second largest merchant producer of aniline and the only U.S. producer of nitrotoluenes. First Chemical Pascagoula is located in the Bayou Casotte industrial park. The plant employs approximately 180 people and produces a wide range of chemical products. These chemicals are the key ingredients in many everyday items, including pharmaceutical, automotive parts, tires, dyes, photo chemicals, agricultural chemicals and building materials.

1.3.2.6 Enviva Partners, LP

Enviva Partners is a wood pellet manufacturer that signed a multi-year operating agreement with the JCPA to lease terminal space to ship wood pellet biofuel from Bayou Casotte to its customers in Japan. Terminals E and F at the port are currently undergoing construction to build a conveyor system to load the bulk carriers that are anticipated to arrive there beginning in 2020. The pellets would be manufactured at Enviva's existing facility in Amory, MS and three new facilities being constructed in Mississippi. The pellets will shipped by rail to the port and exported to Enviva's customers in Japan, according to the operating agreement. The terminal at Bayou Casotte will have an estimated throughput of 2,000,000 metric tons per year. Enviva will use Panamax-class bulk vessels (70,000 deadweight tons (DWT) capacity) to export the wood pellets, which is consistent with their practices elsewhere in the United States. These vessels have a length of 732 feet, a width of 106 feet, and a draft of 47 feet. Due to this size, the vessels will be restricted to daylight-only transits at Bayou Casotte.

1.4 Prior Studies and Reports

Numerous reports have been prepared by the USACE, Mobile District concerning navigation improvements at the Port of Pascagoula. The first report on the harbor system was submitted in 1828 but was not published. The most recent reports concerning this project are described briefly below:

H.J. Res. 465, 87th Congress, 1st Session (Pub. L. 87-65 June 30, 1961). H.J. Res.465 was transmitted to Congress on January 13, 1961 and recommended modification to provide for deepening the Horn Island Pass Channel to 38 feet; deepening the main ship channel in Mississippi Sound, the

Pascagoula River Channel to the railroad bridge, and the turning basin to 33 feet. Construction of the recommended improvements was completed June 13, 1962.

H.D. 560, 87th Congress, 2nd Session (River and Harbor Act of 1962, Pub. L. No. 87-874, October 23, 1962). This report recommended modifications to the project to provide for an entrance channel, from deep water in the Gulf of Mexico through Horn Island Pass, 40 feet deep and 350 feet wide, including an impoundment area for littoral drift 40 feet deep, 200 feet wide, and about 1,500 feet long adjacent to the channel at the west end of Petit Bois Island; a channel 38 feet deep and 350 feet wide in Mississippi Sound and the Pascagoula River to the railroad bridge at Pascagoula, including a turning basin approximately 2,000 feet long and 950 feet wide (including the channel area) on the west side of the river below the railroad bridge; and a channel 38 feet deep and 225 feet wide from the ship channel in Mississippi Sound to the mouth of Bayou Casotte, thence 38 feet deep, 1,000 feet wide, and 1,750 feet long. The 1962 River and Harbor Act authorized the improvement and the work was completed in August 1965.

Pascagoula Harbor, Mississippi, Feasibility Report, Improvement of the Federal Deep Draft Navigation Channel and EIS on Pascagoula Harbor, dated September 1984. Channel modifications recommended in the 1984 report were authorized by Section 202(a) of WRDA 1986. No H.D. was published for the 1984 Feasibility Report.

Special Management Area (SMA) Plan for the Port of Pascagoula, Jackson County, Mississippi, Ralph M. Field Associates, Incorporated, November 1985. This report documents the result of a three-year interagency consensus planning process to identify a development plan, a mitigation plan and a long-term dredged material management plan. This plan has subsequently been revised several times, most recently in 1997, to approve, among other things, the development of the Bayou Casotte DMMS.

EIS, Designation of an ODMDS located Offshore Pascagoula, Mississippi, USEPA, Region 4, July 1991. This EIS addressed impacts associated with disposal of dredged material from Pascagoula Harbor vicinity in the Pascagoula ODMDS.

General Design Memorandum – Improvements of the Federal Deep Draft Navigation Channel, Pascagoula Harbor, Mississippi, Mobile District, February 1992. This memorandum updated the 1985 FEIS relative to the final design for the restoration of the Grande Batture Island and it discussed the impacts associated with the establishment of approximately 2,100 acres of oyster reefs in conjunction with the restoration of the Grand Batture Island.

Initial Appraisal/Reconnaissance Report, Bayou Casotte Inner Harbor Deepening, Pascagoula Harbor, Mississippi, Mobile District, June 1997. This report recommended conducting feasibility phase investigations to determine the feasibility of deepening Bayou Casotte Harbor.

Limited Reevaluation Report, Pascagoula Harbor Channel Improvement, Phase II, Pascagoula, Mississippi, Mobile District, July 1997. This report recommended construction of a second phase of the authorized project. Construction of project improvements was completed in November 2001 and consists of the following features:

- Deepening the Gulf Entrance Channel and associated impoundment basin to 44 feet at the existing width of 450 feet;
- Deepening the Horn Island Pass Channel and associated impoundment basin to 44 feet at the existing width of 600 feet;
- Deepening the Lower Pascagoula Channel to its junction with the Bayou Casotte Channel to 42 feet at the existing width of 350 feet;
- Widening and deepening the Bayou Casotte Channel to 350 feet by 42 feet to a point approximately 1,200 feet north of the turning basin located at the mouth of the Harbor; and

- Deepening the turning basin at the mouth of Bayou Casotte to 42 feet.

Dredged Material Management Plan (DMMP) for Maintenance of Bayou Casotte Inner Harbor, Pascagoula Harbor, Mississippi, Mobile District, June 1998, revised January 2000. The report recommended construction of the BCDMMS confined disposal facility. The recommended site consists of 136 acres within the dike and provides for over 50 years of disposal capacity for maintaining the existing Federal project and for the non-Federal sponsor's facilities.

Feasibility Report, Bayou Casotte Harbor Extension, Pascagoula, Mississippi, Mobile District, December 1998, revised December 1999. This report recommended the following:

- Deepening the Bayou Casotte Harbor Channel from 38 feet to 42 feet from Station 193 + 17 to Station 241 + 50; and
- Widening the Bayou Casotte Harbor Channel from 300 feet to 350 feet from Station 193 + 17 to Station 215 + 03.

DMMP Pascagoula River Harbor, Pascagoula, Mississippi, Mobile District, September 2003, revised March 2010. The plan provides for at least 30 years of disposal capacity. This report recommended the following:

- Raising the existing dikes at the Triple Barrel upland disposal site to a design height of 35 feet;
- Non-phased construction of a 425-acre confined open-water dredged material management area (DMMA) to the east and south of SRI, including the creation of 150 acres of wetlands; and
- Utilizing existing open-water DMMAs located adjacent to and west of the Upper and Lower Pascagoula Channels; including a revised existing open-water site; and utilizing maintenance dredged material for beneficial uses.

FSEIS For Construction to the Federally Authorized Project Dimensions and Future O&M of the Pascagoula Harbor Navigation Channel, Jackson County, Mississippi, Mobile District, August 2010. The plan addresses the congressionally authorized modification to widen and deepen the channel and continue with maintenance dredging operations. The project is conducted under the authority of, Flood Control and Coastal Storm Emergencies (FCCE) (33 U.S.C. § 701n) (Pub. L. 84-99 December 18, 2005). Appropriation for construction of the project was received making Appropriations for the Department of Defense for the Fiscal Year (FY) Ending September 30, 2006, and for Other Purposes. The original FEIS was reviewed and any new conditions that were not addressed in the 1985 FEIS were evaluated as part of the FSEIS to ensure compliance with all environmental laws and regulations. The plan provides for:

- New work dredging using either hopper, hydraulic, or mechanical dredging methods to increase the Bar Channel width to 550 feet from 450 feet from the 44-foot contour in the Gulf of Mexico to the bend at Horn Island Pass, increase the depth of the upper Pascagoula Channel including the Pascagoula River portion to 42 feet from the split with the Bayou Casotte Navigation Channel to a point 1 mile south of the railroad bridge in the Pascagoula River, and increase the depth of the impoundment basin in Horn Island Pass to 56 feet with placement of dredged material in the littoral disposal area/open water disposal site 10 south of Horn Island and in the Pascagoula ODMDS; and
- Perform future maintenance dredging of the entire Federal Pascagoula Harbor Navigation Project using the Pascagoula ODMDS, upland site (Triple Barrel), wetlands creation at SRI, and open-water disposal sites on the west side of the Pascagoula Harbor Navigation Channel, including the littoral placement site.

Project Information Report, Pascagoula Harbor Navigation Project, Pascagoula, Mississippi, Mobile District, February 2010. This report recommended widening of the Bar Channel by 100 feet to its authorized width of 550 feet.

Project Information Report, Pascagoula River Harbor DMMP, Pascagoula, Mississippi, Mobile District, May 2011. This report recommended constructing the 425-acre open-water dredged material management area, improving the upland Triple Barrel site's capacity, continuing open-water dredged material management areas use, and possible beneficial use of future maintenance material.

Project Information Report, Pascagoula Harbor Navigation Project, Pascagoula, Mississippi, Mobile District, June 2016. This report recommended deepening the Pascagoula River Channel and Pascagoula Upper Channel to their authorized depths of 42 feet.

1.5 Special Management Area

The SMA Plan for the Port of Pascagoula is the result of a three-year-long planning process which included numerous discussion(s) and negotiation sessions as well as field reconnaissance and technical studies on the part of the SMA Task Force. The SMA Plan consists of provisions affecting development in specific geographic areas within the Pascagoula SMA boundaries, provisions for operating under the Plan, and general provisions to be applied throughout the SMA. On November 18, 1985, the Mississippi Commission on Wildlife Conservation approved a revision to the Mississippi Coastal Program to incorporate the Port of Pascagoula SMA Plan into the Coastal Program. The Port of Pascagoula SMA is a conceptual plan that balances the public interest of industrial development, the seafood industry, and the protection of coastal resources. On May 15, 1986, the Office of Ocean and Coastal Resource Management concurred that this revision constitutes a routine Mississippi Coastal Program Implementation action. The revision became effective and federal consistency applied as of June 1, 1986.

The JCBOS and the JCPA will use the SMA Plan as the principal basis for designing specific development proposals for submission to the MDMR, MDEQ-OPC, MDAH, and the USACE. The MDMR, MDEQ-OPC, MDAH, USACE, USEPA, USFWS, and NMFS (signatory regulatory agencies) will use the SMA Plan as a guideline for interpreting their respective agency policies and responsibilities with regard to the acceptability of submitted development proposals within the Pascagoula SMA.

1.6 Public and Agency Involvement, Review, and Consultation

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 [i.e. public and non-governmental organizations (NGOs)] that may have an interest in the project. Methods employed by the study team to reach the general public and interested stakeholders have included meeting announcements, news releases to local print, and a web site. Further public communications included maintaining contact with public officials and agency representatives, ensuring that calls and letters from the public were addressed in a timely manner, and contacting stakeholders through placement of notices of public meetings in stakeholder newsletters. In addition, the DEIS and FEIS has been and/or will be widely circulated and comments have been and/or will be requested and incorporated as applicable.

1.6.1 EIS Scoping Process

NEPA regulations provide for the use of the scoping process to identify and assess reasonable alternatives to Proposed Action(s) that avoid or minimize adverse effects of the action(s) upon the quality of the human 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.

The USACE published a NOI on February 4, 2010 to announce its intention to evaluate improvements to the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels of the Federal navigation project. The public was invited to attend a public scoping meeting to obtain public input and ensure compliance with NEPA. A public scoping workshop was held Thursday, February 25, 2010, to introduce preparation of the Feasibility Study of the Bayou Casotte Harbor Channel Improvement Project, including preparation of the DEIS. The public scoping workshop was hosted by the USACE, Mobile District. The workshop began at 5:30 at the Pascagoula Library in Pascagoula, Mississippi. A court reporter was provided to document any comments provided by attendees. Details of the public scoping meeting are included in *Appendix A: Public Involvement* of this FEIS.

1.6.2 Study Participants and Coordination

Per the Council on Environmental Quality (CEQ) regulations on implementing NEPA, the USACE, Mobile District requested that a number of State and Federal agencies accept the status of Cooperating Agency on the EIS (*Appendix C: Agency Correspondence*). In response to this request, dated February 4, 2010, the following entities are participating as cooperating agencies:

State:

- MDAH
- MDEQ-OPC
- MDMR
- Mississippi Department of Wildlife, Fisheries, and Parks (MDWFP)
- Mississippi Secretary of State (MS SOS), Public Lands Division

Federal:

- Bureau of Ocean Energy Management (BOEM) [formerly known as Minerals Management Service (MMS), Gulf of Mexico Region]
- National Oceanic and Atmospheric Administration (NOAA), NMFS Southeast Region, PRD and HCD
- National Park Service (NPS)
- USCG
- USEPA, Region 4
- USFWS

Local:

- JCPA

1.6.3 Study Participants' Roles and Regulatory Authorities

Table 1.6.3-1
Environmental Laws and Regulations

Law/Regulation/ Executive Order (EO)	Description	Principal Federal Responsible Agency(s)
ESA of 1973	Establishes a national policy designed to protect and conserve threatened and endangered (T&E) species and the ecosystems upon which they depend	USFWS NOAA, PRD
Marine Mammal Protection Act of 1972 (MMPA)	Prohibits the take (i.e. hunting, killing, capture, and/or harassment) of marine mammals, and enacts a moratorium on the import, export, and sale of marine mammal parts and products	NOAA, PRD USFWS
National Historic Preservation Act of 1966 (NHPA) and EO 11593	Seeks to preserve the historical and cultural foundation of the U.S. EO 11593 of 1991 states the Federal Government will provide leadership in preserving, restoring, and maintaining the historic and cultural environment	USACE
CWA	Regulates activities resulting in a discharge to waters of the U.S. 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 to waters of the U.S. shall obtain a certification that the discharge complies with applicable sections of the CWA Section 402 established the National Pollutant Discharge Elimination System (NPDES), which regulates discharges into waters of the U.S. Section 404 established a program to regulate the discharge of dredged or fill material into waters of the U.S. to include tributaries to navigable waters, interstate wetlands which could affect interstate or foreign commerce, and wetlands adjacent to waters of the U.S.	USEPA, USACE
Clean Air Act (CAA)	Establishes limits and regulates how much of an air pollutant can be present in an area anywhere in the U.S. to promote uniformity in basic health and environmental protections	USEPA
Coastal Zone Management Act (CZMA)	Establishes a national coastal management program that comprehensively manages and balances competing uses of and impacts to any coastal area or resource	NOAA, National Ocean Service
Wild and Scenic Rivers Act of 1968	Establishes a National Wild and Scenic Rivers System to protect and preserve the free-flowing waters of the nation's most spectacular rivers. The act safeguards the special character of these rivers while striving to balance river development with permanent protection. The act prescribes the methods and standards through which additional rivers may be identified and added to the system to study areas and submit proposals to the President and Congress for addition to the system.	Secretary of the Interior and the Secretary of Agriculture
Estuary Protection Act of 1968	Authorizes study and inventory of U.S. estuaries, including land and water of the Great Lakes, to determine whether such areas should be acquired by the Federal Government for protection	USDOI

Law/Regulation/ Executive Order (EO)	Description	Principal Federal Responsible Agency(s)
Resource Conservation and Recovery Act (RCRA) of 1976	Provides for comprehensive 'cradle-to-grave' regulation of hazardous waste and authorizes environmental agencies to order the cleanup of contaminated sites	USEPA
Toxic Substances Control Act (TSCA) of 1976	Enacted by Congress to give USEPA the ability to track the 75,000 industrial chemicals currently produced or imported into the U.S.	USEPA
MPRSA of 1972	Regulates ocean dumping in the territorial seas or the contiguous zone of the U.S. and provides for general research on ocean resources (includes designation of marine sanctuaries) and ocean disposal activities	USEPA/USACE
Section 9 of the Rivers and Harbors Act of 1899	Prohibits the construction of any bridge, dam, dike, or causeway over or in any port, roadstead, haven, harbor, canal, navigable river, or other navigable water of the U.S. until receiving consent of Congress	USACE
Coastal Barrier Resources Act (CBRA)	Designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the Coastal Barrier Resources System. Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the Coastal Barrier Resources System.	USDOI, USFWS
EO 11988, Floodplain Management	Requires Federal agencies to avoid to the extent possible the long and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative	Federal Emergency and Management Agency (FEMA)
EO 11990, Protection of Wetlands	Minimizes the destruction, loss or degradation of wetlands and preserves and enhances the natural and beneficial values of wetlands	USFWS
EO 12898: Environmental Justice	Requires Federal agencies to incorporate into NEPA documents an analysis of the environmental effects of their proposed programs on minorities and low-income populations and communities.	USEPA
EO 13045: Protection of Children from Environmental Health Risks and Safety Risks	Each Federal agency is to make it a high priority to identify and assess environmental health risks and safety risks that may disproportionately affect children. The President also directed 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.	USEPA
Wilderness Act of 1964	Assures that an increasing population, accompanied by expanding settlement and growing mechanization, does not occupy and modify all areas within the U.S. and its possessions, leaving no lands designated for preservation and protection in their natural condition, it is hereby declared to be the policy of the Congress to secure for the American people of present and future generations the benefits of an enduring resource of wilderness.	All Federal agencies
Magnuson-Stevens Fishery Conservation and Management Act (MFCMA) and EFH	Establishes and delineates an area from the states' seaward boundary out 200 nm as a fisheries conservation zone for the U.S. and its possessions. Established national standards for fishery conservation and management, and created eight regional Fishery Management Councils (FMCs) to apply those national standards in FMCs. EFH is defined as the water and substrate necessary for fish spawning, breeding, feeding, and growth to maturity.	NMFS, HCD

Source: USACE.

1.6.4 Coordination, Collaboration and Data-Sharing with NGOs

The study team invited participation from members of NGOs, such as The Nature Conservancy (TNC), The Sierra Club, and The Audubon Society, as well as many other groups throughout the region and the state. Members of these organizations have participated in various meetings during which specific goals of the study were discussed as well as potential measures and alternatives that would allow the USACE to meet stated goals and objectives. Comments from these NGOs have been considered and have been incorporated into the Bayou Casotte Harbor Channel Improvement Project FEIS.

1.6.5 Internet Web Site

Documents associated with the project can be found at:
http://www.sam.usace.army.mil/Missions/PlanningEnvironmental.aspx

2 STUDY AREA DESCRIPTION

2.1 Study Area and Environmental Setting

The Port of Pascagoula, Bayou Casotte Harbor is located in Jackson County, Mississippi, in the southeastern-most portion of the state in the Mississippi Sound ("the Sound") and it is positioned south of the juncture of Interstate-10 and Mississippi Highway 63. The Port of Pascagoula is accessible from the Gulf of Mexico by a shipping channel located through the pass between Horn Island and Petit Bois Island in the Mississippi Sound.

Environmental characteristics that may be affected by the Proposed Action and other alternatives include geological, chemical, biological, socioeconomic, commercial, and recreational activities. Onshore, the regional environment is characterized as coastal lowlands, and the shore area, where not developed, consists typically of gently undulating swampy plains (USACE, 1985b).

2.1.1 General Description of the Study Area

The project is located primarily within Mississippi Sound, a shallow coastal lagoon which extends 9 miles offshore and encompasses the area between Mobile Bay, Alabama to the east and Lake Borgne, Louisiana, in the west. The MLLW depth of the Mississippi Sound is 13 feet, and over 99 percent of the area is less than 20 feet deep. The dredged shipping channel ranges from 42 to 48 feet deep (with advanced and overdepth dredging).

The continental shelf located off Pascagoula is topographically diverse and includes slopes, escarpments, knolls, basins, and submarine canyons. Horn Island and Petit Bois Island are approximately 7 to 9 miles offshore and are part of the barrier islands in this region. Generally, these islands feature broad, sandy beaches to the north with dunes on the southern Gulf side. These islands have migrated westward with time, and will continue to do so because of continual erosion on the eastern ends and accretion on the western ends (USACE, 1989).

The benthic habitat of Mississippi Sound is a dynamic environment. The nearshore coastal processes produce forces that change the sediment composition and associated benthic community. A study compared the 1980 and 2005 sediment composition and benthic invertebrate communities at 100 locations near SRI (USACE, 2005). A substantial change was observed in sediment composition and community structure over the 25-year timeline. During that time period, a major shift in sediment texture (increase in percentage of sand) was observed with a dramatic decrease in both taxa richness and macroinvertebrate density. These results are reflective of the typically dynamic nature of the benthic communities in shallow coastal areas of the Gulf of Mexico. A substantial change was observed in the sediment composition and community structure over the 25-year timeline.

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 land area. Main rivers draining into Mississippi Sound are the Pascagoula, the Pearl, and the Mobile River(s). This mix of freshwater and saline conditions has created a dynamic estuarine environment (NOAA, 2004a). The area is characterized by a humid, warm-temperate, sub-tropical climate, and is partially isolated from the Gulf of Mexico.

Circulation patterns of the mid-shelf and deepwater regions are influenced by the Loop Current (USEPA, 1986). 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, 2004b). The region of the Mississippi River outflow contains the highest rates of primary production in the Gulf of Mexico. Climatic events, such as hurricanes, may also increase

phytoplankton biomass and primary production as a result of vertical advection of nutrients to surface waters (NOAA, 2004b).

Sediments range from sands to silts and clays. Nearshore benthic and nektonic communities are diverse and seasonally variable; mid-shelf and deepwater communities are typically less diverse with lower biomass (USEPA, 1986).

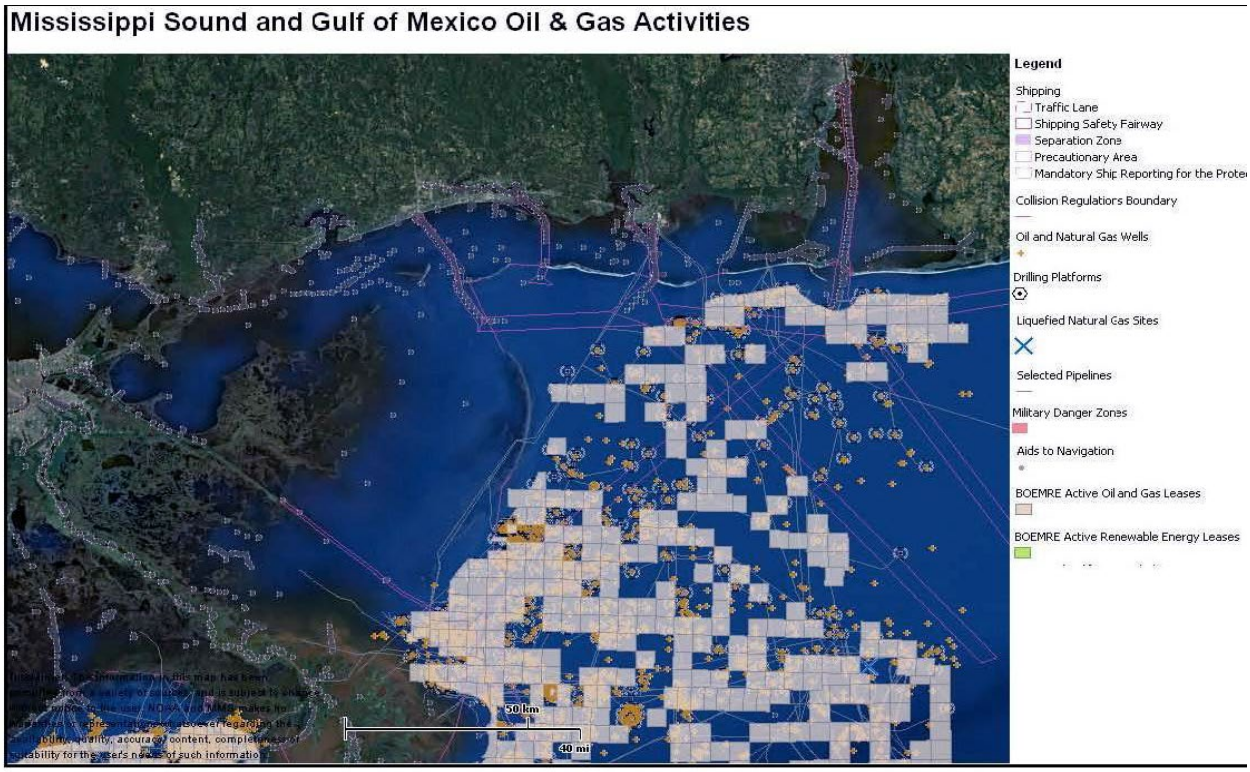
The Gulf of Mexico marine ecosystem exhibits signs of overall ecosystem stress in bays, estuaries, and coastal regions. Shoreline alteration, pollutant discharge, oil and gas development, and nutrient loading are the primary stress factors within the Gulf area (NOAA, 2004b). Farther west into the Gulf of Mexico, there is a regional occurrence of hypoxic waters. Productivity in hypoxic waters is much lower than in other regions of the Gulf, with lower than expected levels of shrimp and fish (USACE, 1994). Hypoxia is known to occur in shelf waters off of the Louisiana coast during the summer and (based on reports from fishermen) apparently extends to Gulf waters east of the Mississippi River as well. Hypoxia has not been linked to disposal of dredged material (USACE, 1994) and was not observed at the sampling stations in the project study area (MDEQ, 2006a and USACE, 2006b).

Environmental conditions within the Gulf of Mexico (outside of the hypoxic zone) are generally defined by good dissolved oxygen (DO) concentrations; fair water quality; poor coastal wetlands; eutrophic conditions; and poor sediment, benthos, and fish tissue quality (USEPA, 2001). In 2008, the Mississippi River/Gulf of Mexico Watershed Nutrient Task Force established a goal to reduce nitrogen discharges to the Gulf by 30 percent by the year 2015. In the February 2015 Report to Congress, the Hypoxia Task Force announced that it would retain its goal of reducing the areal extent of the Gulf of Mexico hypoxic zone to less than 5,000 km^2, but that it will take until 2035 to do so. The Hypoxia Task Force agreed on an interim target of a 20 percent nutrient load reduction by the year 2025 as a milestone toward achieving the final goal in 2035. (Mississippi River/Gulf of Mexico Watershed Nutrient Task Force, 2015). Other goals established include a reduction of the hypoxic zone, increased agricultural efficiency, urban non-point source pollution removal, upgraded sewage treatment facilities, and increased oil pollution control measures (NOAA, 2004b**).**

The nearshore area is used for commercial and recreational shipping, boating, and fisheries. Substantial fisheries resources are known to exist in the area. A high number of oil and gas facilities along with several fish havens, artificial reefs, and shipwrecks are located in the area. Areas within the barrier islands and Mississippi Sound are considered important migration areas for marine mammals and coastal birds, such as the Atlantic bottlenose dolphin and brown pelican, and are used as foraging habitat for Gulf sturgeon. Deeper water areas (>98 feet) beyond the barrier islands contain important commercial fish and shrimp fisheries, fish havens, shipwrecks, and offshore banks. Oil and gas activities have expanded in recent years and applications for oil and gas leases in those areas are increasing (Figure 2.1.1-1).

The Deepwater Horizon oil spill, which started April 20, 2010, discharged into the Gulf of Mexico through July 15, 2010. According to government estimates, the leak released between 100 and 200 million gallons of oil into the Gulf. The USCG estimates that more than 50 million gallons of oil has been removed from the Gulf, or roughly a quarter of the spill amount. Additional impacts to natural resources may be attributed to the 1.84 million gallons of dispersant that has been applied to the spill. Approximately 625 miles of Gulf Coast shoreline experienced some form of oil (approximately 360 miles in Louisiana, 105 miles in Mississippi, 66 miles in Alabama and 94 miles in Florida).

Figure 2.1.1-1
Oil and Gas Activity in the Gulf of Mexico



Source: USACE.

2.2 Physical Characteristics

2.2.1 Physiography/Geology

The Mississippi Coast is situated in the Outer Coastal Plain Mixed Forest Province Ecoregion according to the U.S. Department of Agriculture's (USDA) *Description of the Ecoregions of the United States* (Bailey 1995). Along the coast, flat coastal plains generally have gentle slopes and local relief of less than 100 feet. Water bodies of the area are typically characterized as sluggish streams, marshes, lakes, and swamps.

There are two major physiographic regions in the Mississippi coastal region. The Gulf Coast Flatwoods form an irregular belt through the southern half of the three-county region. This belt consists mainly of wet lowlands and poorly drained depressions, with some higher, adequately-drained areas. The second physiographic region, the Southern Lower Coastal Plain, is rolling and gently undulating interior uplands. Elevations range from sea level along the coast in Hancock, Harrison, and Jackson Counties to about 420 feet above sea level in the far northern areas of the coastal region. The slope of the land surface is generally oriented to the south. The area is underlain by a thick sequence of sedimentary deposits dipping to the south and west.

The Coast of Mississippi is composed of sedimentary rocks and sediments deposited between the Cenozoic era and Quaternary period. Sedimentary layers of Pliocene, Miocene, Oligocene, and Eocene age currently found in the coastal Mississippi area consist of clay, silt, sand, gravel, and limestone. All these formations dip to the south-southwest. The geologic formations exposed on the surface of the Mississippian Gulf Coast are up to 100 feet thick and consist of alluvium and terrace deposits. The Biloxi Formation, the Prairie Formation, and the Gulfport Formation were all deposited during this time. The Biloxi Formation was deposited during a period of rising sea level in marine and brackish water both nearshore and offshore. This formation is not exposed at the surface, except along the banks of the Industrial Seaway in Gulfport where it has been exposed from excavation. It ranges in thickness from 15 feet in Harrison County up to 120 feet in Jackson County, and consists of clay, fine sand, and sandy clay with abundant fossils. Both shells and microscopic foraminifera are found, and these fossils are used to identify the deposition environment (Oivanki 1993). The Prairie Formation, ranging from 15 to 40 feet thick, was deposited in river channels and inter-channel swamps. It is composed primarily of sands and muddy sands with petrified tree trunks and organic matter, and is visible along the Industrial Seaway road cut in Harrison County. The formation underlies the wide, generally flat coastal plain immediately north of the coastal marshes and beaches on the coast. The City of Bay St. Louis is built on the high sandy bluffs of the Prairie Formation (Oivanki 1993). The Gulfport Formation is a sand unit that was deposited during a time of sea level decline, following the highest sea level stage of the Pleistocene epoch. It forms the high ridge upon which the coastal cities of Pass Christian, Gulfport, and Biloxi are built. The coastal Mississippi beaches are regularly replenished with sand dredged from Mississippi Sound, and the source for much of this sand is the Gulfport Formation. Holocene sediments are predominantly found in the Pascagoula Bay shoreline and consist mostly of sandy fine-grained silts and clays with significant organic material (such as marshes), are generally unconsolidated, and range in thickness from 2 to 14.5 feet (Schmid and Otvos, 2004; Mississippi Department of Geology, 2007).

Currently, the northeastern Gulf of Mexico, from western Florida to the Mississippi Delta, is distinguished by three major systems: the Mississippi-Alabama Shelf system, the western Florida barrier island system, and the Mississippi Sound barrier island system (USEPA, 1986). The Gulf of Mexico in the vicinity of Pascagoula is characterized by the Mississippi-Alabama Shelf system. This system forms a triangular area south of the Mississippi barrier islands and extends from the Mississippi River Delta to the De Soto Canyon to the 656-foot contour. The Mississippi-Alabama Shelf system is about 80 miles wide at its western edge and narrows to 35 miles to the east. It is broad and nearly a flat plain bounded on the landward side by the relatively steep and narrow shoreface of the Mississippi

Sound. Along the barrier islands, the break in slope between shoreface and shelf occurs at about 20 feet. In the eastern portion of the barrier islands, in the vicinity of Dauphin Island, the shoreface has a gradient of 50 to 60 feet per 0.62 mile and the shelf has a gradient of approximately 3.2 feet per 0.62 mile (USEPA, 1991).

Both the Mississippi Sound and Florida barrier island systems are composed of segmented chains of sandy islands broken by shallow passes having widths comparable to the lengths of the islands. Cat, Ship, Horn, Petit Bois, and Dauphin Islands comprise the Mississippi Sound barrier island system. The barrier islands along the Mississippi, Alabama, and western Florida coast were formed during the submergence of dune beach ridges in the early Holocene, approximately 4,000 years ago (USEPA, 1986). At that time, these islands formed an island-shoal barrier 143 miles long between Dauphin Island and the current location of metropolitan New Orleans. Between 2,300 and 3,000 years ago, St. Bernard Delta sediments from the Mississippi River migrated into the Gulf of Mexico and settled onto the sea bottom from 2 to 12.5 miles south of Cat, Ship, and Horn Islands. These sediments reduced wave energy from the west and stopped sediment accretion on Cat Island. After the Mississippi River changed course and the St. Bernard Delta sediments no longer flowed into the Gulf, erosion of existing delta sediments led to the erosion of the Mississippi coast marshlands (USACE, 1989).

The barrier islands migrate to the west over time, due to accretion of sediments on the western ends and erosion on the eastern ends. The barrier island facies are typically well-sorted, medium grained, mature quartzose sand with less than 3 percent feldspar and a mineral suite rich in staurolite and kyanite. The facies has an average width of 2.5 miles and an average thickness of 40 feet. The barrier islands tend to feature sand beaches with dunes on the south shore and beach or intermittent marsh on the north shore. The island interiors are typically broad, low sand flats that are 1 to 2 feet above sea level or vegetated beach ridges 5 to 15 feet above sea level (USACE, 1989).

The physiography and geology of coastal Mississippi were largely unaffected by the hurricanes of 2005; however, saltwater intrusion into sediments and water bodies as a result of inundation during Hurricane Katrina in particular, has been evident. The storm surge associated with Hurricane Katrina brought saltwater into many freshwater features that would not normally be impacted by saline waters. The level of saltwater intrusion by inundation caused die-off of many species, only some of which have re-grown by this late date. Die-off of trees impacted by saltwater was particularly severe on the barrier islands, which to-date, have never recovered. While much of the saltwater is no longer present in soils or rocks within the study area, its effect on vegetation has not been reversed in many areas.

2.2.2 Bathymetry

Mississippi Sound is a 100-mile long lagoon system that stretches from Lake Borgne, Louisiana to Mobile Bay, Alabama, encompassing 1,184,129 acres. This includes the entire Mississippi coast. Mississippi Sound is mostly separated from the open Gulf of Mexico by a series of barrier islands. From east to west these islands include Dauphin, Petit Bois, Horn, Ship, and Cat Islands and associated sand bars (USFWS, 1982).

Mississippi Sound has a mean depth of 13 feet. However, the depth over the length of the Sound is not uniform. There are two different regions with markedly different bathymetric features (Blumberg et al., 2000). The upper and western Mississippi Sound is shallow, with depths ranging from about 3 feet to 9 feet. The remainder of the Gulf of Mexico is deeper, ranging from about 9 feet to more than 600 feet in depth, with the deepest areas south of the barrier islands. Where the Pascagoula Harbor Navigation Channel extends across the Mississippi Sound, the northern half of that portion of the Sound has natural water depths of about 13 feet or less. Depths in the southern half range from approximately 13 to 20 feet. South of Horn Island, natural depths range from approximately 20 to 45 feet in the vicinity of the ship channel. The islands are separated by approximately 3 nm of open water, which ranges in depth from 1 to 20 feet. The currents around the barrier islands transport sand

and tend to extend the western edges of the islands and erode the eastern ends. As the islands move west, the channel also shifts west.

The Bar Channel is 550 feet wide and 44 feet deep, widening to 600 feet at the Horn Island Pass. The pass narrows into the 350-foot wide, 42-foot deep Lower Pascagoula Channel. The Bayou Casotte Channel splits from the Lower Pascagoula Channel at the "Y" junction in the middle of Mississippi Sound. At Bayou Casotte Harbor, there are two turning basins. The southern turning basin is located on the west side of the mouth of Bayou Casotte and is maintained at a depth of 42 feet deep with a turning diameter of 1,125 feet (including the channel area). The northern turning basin is located at the terminus of the Federal project in Bayou Casotte and is maintained at a depth of 42 feet, 840 feet in width, and 1,750 feet in length). The Upper Pascagoula Channel narrows at the "Y" junction to a depth of 42 feet by 350 feet wide terminating at the railroad bridge crossing. The channel includes a turning basin at a depth of 38 feet by 2,000 feet long and 950 feet wide. The Pascagoula River Channel continues northward at a depth of 22 feet by 150 feet wide from the bridge up into the Escatawpa River to the Highway 613 Bridge. It then narrows to 12 feet deep by 125 feet wide from the Highway 613 Bridge, via the Robertson and Bounds Lakes, to Mile 6.0 on the Escatawpa River. An even narrower channel, 12 feet deep and 80 feet wide, extends 1,500 feet from the 22-foot deep Pascagoula River Channel to a turning basin in Krebs Lake, then a channel 10 feet deep and 60 feet wide along the south bank of Krebs Lake, terminating at a second turning basin, a distance of 2,700 feet from the first.

The open-water disposal sites along the west side of the channel extend from disposal area 5, located south of SRI, to disposal area 9, located just north of Petit Bois and Horn Islands. Along Bayou Casotte channel, open-water disposal sites 3 and 4 are positioned to the east. At the more inshore disposal areas (5 and 6), typical depths range from 7 to 10 feet. Open-water disposal sites 3 and 4 consist of depths ranging from less than 4 feet to greater than 10 feet. At disposal areas 8 and 9 in the mid-Sound, the depths range from 12 to 15 feet. The nearshore LZPA is located between Horn Island and Petit Bois Island, with depths ranging from 5 to 30 feet. The Pascagoula ODMDS is an area of approximately 24.3 nautical square miles with depths varying from around 30 feet in the north to over 60 feet in the southern section.

2.2.3 Climate

The coastal area is a humid, warm-temperature to sub-tropical climate. Occasional subfreezing temperatures occur in the area. The Gulf of Mexico greatly influences air temperatures of the coastal counties. During the spring months of March through May, synoptic scale weather systems, highlighted by very active frontal passages, move through the region on an average of every 5 to 7 days. The average temperature is 67° Fahrenheit (F) with a mean minimum of 57° F and a mean maximum of 77° F. The prevailing wind direction is typically east-southeast to southeast at 6 to 12 knots outside of thunderstorms. Passage of frontal systems is significantly reduced during the summer months of June through August. Hot and hazy conditions are normal with an average temperature of 81.7° F while the mean minimum temperature is 72.8° F and the mean maximum is 91.2° F. The prevailing wind direction maintains a southerly component at 4 to 8 knots, outside of thunderstorms. Thunderstorms and rain showers diminish during the September to November time period. The average temperature is 69° F with a mean minimum temperature of 58.5° F and a mean maximum temperature of 78.5° F. A 4 to 7 knot north-northwest prevailing wind is dominant during this period. From December to February, synoptic scale weather systems pass through the region with a northerly prevailing wind direction of 5 to 11 knots. The average temperature is 52° F with a mean minimum of 41.5° F and a mean maximum of 62.1° F. The record low temperature for the region, 5° F, was recorded during this period.

Tornadoes and hurricanes occur in Mississippi. Historical tornadic activity in the Pascagoula area is below the Mississippi state average, but is 39 percent greater than the overall U.S. average (City-data.com, 2007). The Pascagoula area is subject to hurricanes between June and October, with hurricanes most frequent 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 the Mississippi and Alabama coasts (USEPA, 1991; University of Delaware [UD]; 2006). Hurricane damage to shipping facilities in 2005 reduced shipping traffic to the Port of Pascagoula and other regional ports. Shipping traffic rebounded in 2006 (UD, 2006), and the area continues to recover.

2.2.3.1 Precipitation/Rainfall

Average annual rainfall ranges from approximately 65 inches at Biloxi and Gulfport, to approximately 67 inches at Pascagoula. Locally violent thunderstorms are a threat on an average of 60 days each year (Mississippi State Climatologist, 2012). The area has been struck by at least eight hurricanes since 1895, and as of 201 has been affected by 82 tropical disturbances (including hurricanes) since 1915.

2.2.4 Hydrology and Hydraulics

The Coast of Mississippi is governed by often large volumes of rainfall, delivered on a very flat landscape. Principal rivers discharging into Mississippi Sound include the Pearl and Pascagoula Rivers; the Escatawpa River flows into the Pascagoula River at Pascagoula. Other principal rivers discharge into either Bay St. Louis or Biloxi Bay, which are connected to Mississippi Sound. The Wolf and Jourdan Rivers flow into Bay St. Louis, and the Biloxi and Tchoutacabouffa Rivers flow into Biloxi Bay. River patterns meander broadly through this flat and often marshy landscape, and often display abandoned “oxbows” and off-channel wetlands. Numerous bayous are also interspersed within these coastal bays and along the Mississippi Sound shoreline. Many of these bayous have been heavily modified over the years by development and conversion for commercial, residential, industrial, or recreational purposes.

The landscape is generally low-lying on the eastern and western ends of the Mississippi Coast, with higher ground in the middle. The great majority of the ground surface south of Interstate-10, which crosses the state within five to ten miles of the coastline, is below 25 feet above mean sea level, with the preponderance of the area below 15 feet in Jackson and Hancock counties and in the bay and riverine margins of Harrison County. The occurrence of large rainfall and/or hurricane events in coastal Mississippi may normally cause extensive flooding, although nothing in the modern record has ever approached the severity of inundation caused by Hurricane Katrina. Rain-induced riverine flooding in the larger coastal river basins does not generally coincide with hurricane surge, though torrential tropical storm and hurricane rainfall can exacerbate flooding due to surge in the smaller coastal basins. Flooding may also be exacerbated by sediment and debris blockage of channels, culverts, bridges, and canals.

2.2.5 Physical Oceanography

Mississippi Sound is a shallow coastal lagoon bordered by the coastlines of Alabama, Mississippi, and eastern Louisiana to the north and a string of barrier islands and interspersed tidal passages to the south. Three navigation channels from Gulfport, Pascagoula, and Biloxi traverse the Sound; authorized depths of the channels are 36-38 feet, 42-44 feet, and 12 feet (plus varying advanced and overdepth dredging), respectively. Dredged material from the maintenance of these channels is placed

in open-water sites, beneficial use, upland, littoral, and/or ocean disposal site(s). The GIWW, with an authorized depth of 12 feet, spans the Sound from east to west (Jarrell, 1981).

Tides are a primary force that drives the water mass movement in Mississippi Sound. Tides breakdown vertical stratification through mixing action, result in residual circulation through ebb and flood currents, and act to maintain suspension of material in the water. Tides in Mississippi Sound are diurnal, with an average range of 1.4 feet to a maximum of 1.9 feet. The two principal components of the tide (luni-solar and principal lunar) have periods of 23.93 and 25.84 hours, respectively. Every 14 days, the Sound experiences equatorial tides and the diurnal tide is reduced to a mean range of 0.2 feet (Kjerfve and Sneed, 1984). Tides in the Sound are modified by the bathymetry, geometry of the basin, river discharges, and winds (Jarrell, 1981).

Tidal movements, upon entering the Sound, are restricted by bathymetry. Tidal wave fronts approach the Sound from the south. The most rapid movement in the wave front occurs in deeper water toward Petit Bois Island, which splits the tide into two wave fronts. The western portion of the wave advances to the north-northwest, causing a slight counterclockwise rotation. The eastern portion of the wave moves rapidly to the east, resulting in a strong clockwise rotation (Kjerfve and Sneed, 1984).

River discharges of freshwater into Mississippi Sound consist of five primary sources – the Mississippi River, the Lake Pontchartrain basin, the Pearl River, the Pascagoula River, and the Mobile River. On average, 635,664 cubic feet per second (cfs) of freshwater and associated suspended sediment load enter the Mississippi Sound region annually. The Mississippi River represents 83 percent of the freshwater flow. The Pascagoula River is the largest river flowing directly into the Sound and supplies the greatest portion of freshwater and sediment near the navigation channel. Inflow into the Sound is also supplied by numerous streams and bayous, including the Jourdan, Wolf, and Biloxi Rivers. Approximate annual inflow is 10,771 cfs from the Pearl River, 14,726 cfs from the Pascagoula River, and 61,801 cfs from the Mobile River. Mississippi River and Lake Pontchartrain basin inflows are more variable due to the use of floodways on the Mississippi River. The Lake Pontchartrain basin inflow is typically 6,639 cfs, but may increase to 14,136 cfs during use of the Bonnet Carré Floodway. Flows from that floodway, when opened, have historically lasted 13 to 75 days. The plumes and water masses created by these sources act to form density fronts and variable salinity concentrations. For example, flow from the Mississippi results in low-salinity water entering the Sound from the south and southwest. River runoff from all freshwater sources displays a pronounced seasonal variation (Kjerfve and Sneed, 1984). Flows are typically highest in the spring and lowest in late summer and fall.

Wind-driven currents are the primary non-tidal water motions in the Sound. Wind-driven currents and atmospheric pressure raise and lower local sea levels depending on strength and direction, up to +/- 3.3 feet along the coast. The Gulf Coast region experiences two distinct seasonal weather patterns that influence wind direction and strength. In the winter, storms and fronts are frequent. These events are associated with strong changes in local and regional winds and in atmospheric pressure. Winter winds typically blow strongly from the north. Summer weather is dominated by semi-permanent sub-tropical conditions with fronts that are less frequent, occurring every 2 to 3 weeks, and less energetic. Light and variable winds are typically out of the south and southwest (Kjerfve and Sneed, 1984). Sustained south and southeast winds push water into the Sound, while north winds drive the water out (Jarrell, 1981).

The Loop Current, a counterclockwise rotating flow, is the major oceanographic feature affecting offshore circulation. It serves as the feeder current for the Florida Current and Gulf Stream (Kjerfve and Sneed, 1984). Closed rings of clockwise-rotating water often break away from the Loop Current forming eddies or 'gyres' which affect regional current patterns (Thompson et al., 1999). At times, the Loop Current extends onto the continental shelf east of the Mississippi Delta and may influence the flow conditions and water elevation in Mississippi Sound (Kjerfve and Sneed, 1984).

Current meters deployed in the Sound have identified current characteristics that vary with season. During winter (November – January), mean surface flow direction is toward the west and bottom currents are directed toward the north and west. During spring (March-May), surface currents are generally to the east with bottom currents to the north, with the exception of currents passing along the eastern side of Petit Bois Island. Both surface and bottom currents in that area tend toward the north. During summer, both surface and bottom currents are largely directed toward the west (Kjerfve and Sneed, 1984). Detailed oceanographic information was obtained from the NOAA weather buoy 42015 located southeast of the project location (NOAA, 2007a).

Wave heights and wave periods are closely correlated with wind speed. Smallest wave heights and periods occur in the summer, notably July and August. The smallest average wave height occurs in July (1.3 feet), while the average low wave period occurs in August and September and is approximately 3.9 seconds. Significant wave heights decrease slightly in late fall and winter. In late summer and early fall, tropical low pressure systems can dramatically increase both wave height and period. Wave periods show less variation, averaging between 3.9 to 4.3 seconds throughout the year.

Sedimentation in the navigation channels is related to flocculation of clay particles. Except where current-induced mobilization of sediments is elevated, such as at the Pass or during storm events, flocculation and settlement are the primary means by which channels are in-filled. Mississippi Sound is in a constant state of flux due to continual wind and wave action and its shallow depths. Shorelines along the mainland have been erosive over the years and most have been hardened by bulkheads, seawalls and other armoring.

2.2.5.1 Salinity

The Pearl and Pascagoula Rivers contribute the greatest portion of freshwater runoff to the Mississippi coastal area (Christmas, 1973). Salinity characteristics of Mississippi Sound are the result of river runoff and the tidal salt wedge. Salinity in Mississippi Sound fluctuates seasonally (Christmas and Eleuterius, 1973). On a seasonal basis, surface salinity near Pascagoula Harbor ranges from 14 part per thousand (ppt) in the spring to >22 ppt in the fall. The bottom salinity near the harbor has the same range. Around Horn Island salinity normally ranges from 28-30 ppt (Gulf of Mexico Foundation, 2003). The salinity observations in the Sound typically range from 20 and 30 ppt on the surface and 30 and 35 ppt at the bottom (Kjerfve.and Sneed, 1984). Lower salinity prevails near the Mississippi Coast. A longitudinal decrease in salinity occurs in the Sound from east to west. Salinity in the western portion of the Sound also tends to be more uniform (Eleuterius, 1976).

2.2.5.2 Circulation

Tidal flow enters primarily along the western end of Horn Island and through Horn Island Pass. The Pascagoula Harbor Navigation Channel permits the intrusion of higher-salinity water into and across Mississippi Sound. Bottom salinities ranging from 33 to 34 ppt were recorded in the upper Pascagoula Channel in a survey conducted in 2005 (USACE, 2006b). However, channel waters located below the natural depth of the Sound are largely confined to the channel.

During periods of peak freshwater inflow, salinity is sharply reduced in a west-to-east direction. Outflow from the east passage of the Pascagoula River tends to be directed seaward by dredged material placed along the western portion of the Pascagoula Harbor Navigation Channel. Outflow from the west passage flows into the area leeward of Horn Island toward Dog Key Pass (Eleuterius, 1976).

During a sediment sampling event in 2009 by the USACE, Mobile District, water samples were collected from within the federally authorized navigation channel. In the Pascagoula River, Pascagoula Upper and Lower Channels, and Bayou Casotte portions, mean salinities were 24.8 ppt, 20.2 ppt, and 25.6 ppt, respectively.

2.2.6 Sea Level Change

USACE guidance (ER 1100-2-8162) requires consideration of projected future sea-level changes and impacts in project planning, design, operations, and maintenance. Since future sea level rise rates are uncertain, planning and design should consider project performance for a range of sea level change rates. Historical rates are used as the lower bound sea level change rate. Predictions of future sea level due to intermediate and high rates of sea level change are to be developed in accordance with USACE guidance by extension of rate Curve 1 and Curve 3, respectively, from the National Research Council's 1987 report *Responding to Changes in Sea Level: Engineering Implications.*

Historic rates of sea level change are determined from tide gage records. Long-term tide gage records on the order of 40 years are preferred over shorter term records because the sea level change rate estimate error decreases as the period of record increases. There are three long-term tide gages in the vicinity of Bayou Casotte: Dauphin Island, Pascagoula, and Biloxi. The Pascagoula gage is owned and operated by the USACE, Mobile District and is closest to the project location. However, because the gage is located within the Pascagoula River Channel, the water surface elevation there is influenced by riverine discharge and would not be expected to be as representative of open water conditions in the Bayou Casotte and Lower Pascagoula Navigation Channels as Mobile District's Biloxi gage number 02480351 or the U.S. Geologic Survey (USGS) Dauphin Island gage number 8735180. Sea level rise rates for these locations are shown in Table 2.2.6-1. The rate of rise shown for Biloxi was fitted to annual mean tide level data by the method of least squares. The rate of rise shown for Dauphin Island was fitted by a slightly different method and obtained from NOAA technical report NOS CO-OPS 053. The difference in fitting methods is immaterial for present purposes.

Table 2.2.6-1
Historic Sea Level Rise Rates

Location	Rise in mm/yr	Std. Error of Rise
Dauphin Island, Alabama	2.89	0.87
Period of Record	1966-2006	
Biloxi, Mississippi	2.26	0.26
Period of Record	1928-'76, '79-98	
Pascagoula, Mississippi	3.72	0.30
Period of Record	1940-1997	

Source: USACE.

USACE, Mobile District's Biloxi gage number 02480351 is located near Point Cadet and is about two miles closer to the project reach than the USGS Dauphin Island gage number 8735180. It is otherwise unclear which gage would best represent perspective conditions at Bayou Casotte, owing to the following differences:

- The Biloxi gage is located on the mainland fringe and may be more geotechnically stable than the Dauphin Island gage, which is on a barrier island with resource extraction platforms in the near vicinity.
- Biloxi has a longer period of record (68 years versus 41 for Dauphin Island), though it is intermittent.

Predicted rise scenarios for the Biloxi and Dauphin Island sites were computed in accordance with current USACE guidance and are shown in Figure 2.2.6-1 and Figure 2.2.6-2. Predicted rise varies

between about 0.8 feet and 1-foot. Use of Dauphin Island relative sea level rise rates in the predictive equations results in about 0.25 feet (three inches) greater rise over the 100-year period 2000-2100 than predictions using rates determined from the Biloxi gage data.

Figure 2.2.6-1
Sea Level Rise Predictions, USACE gage 02480351 Biloxi, MS

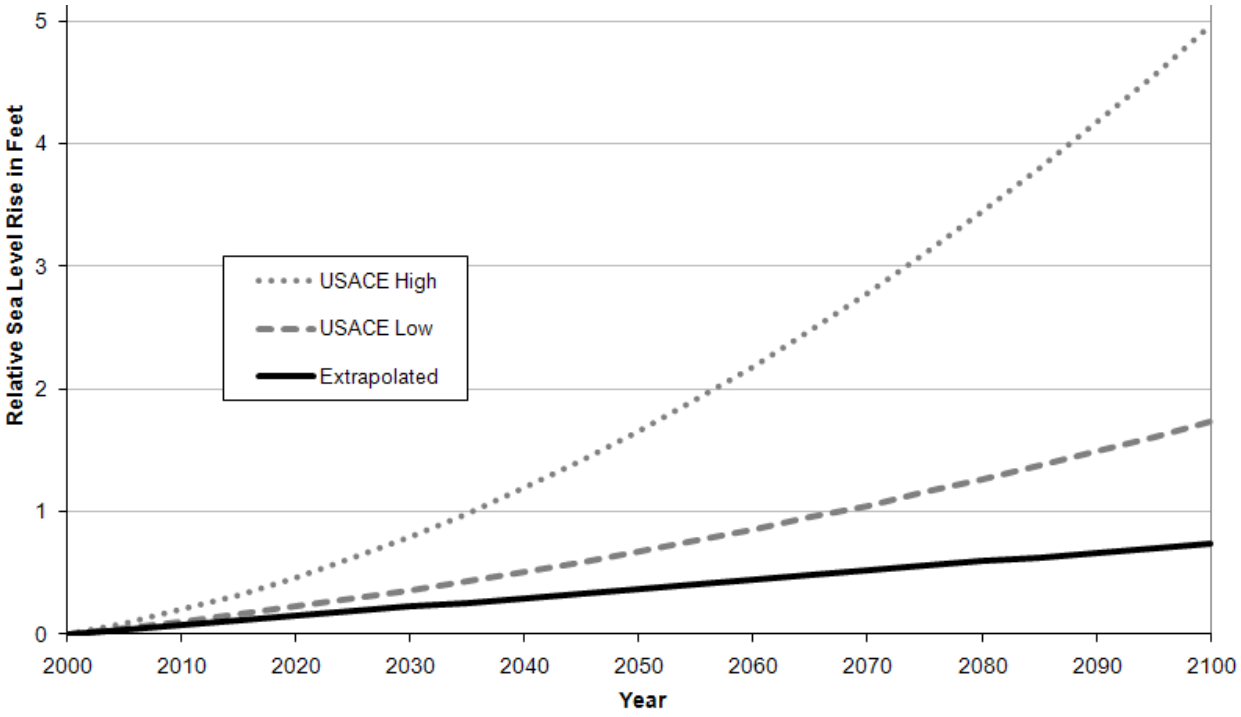
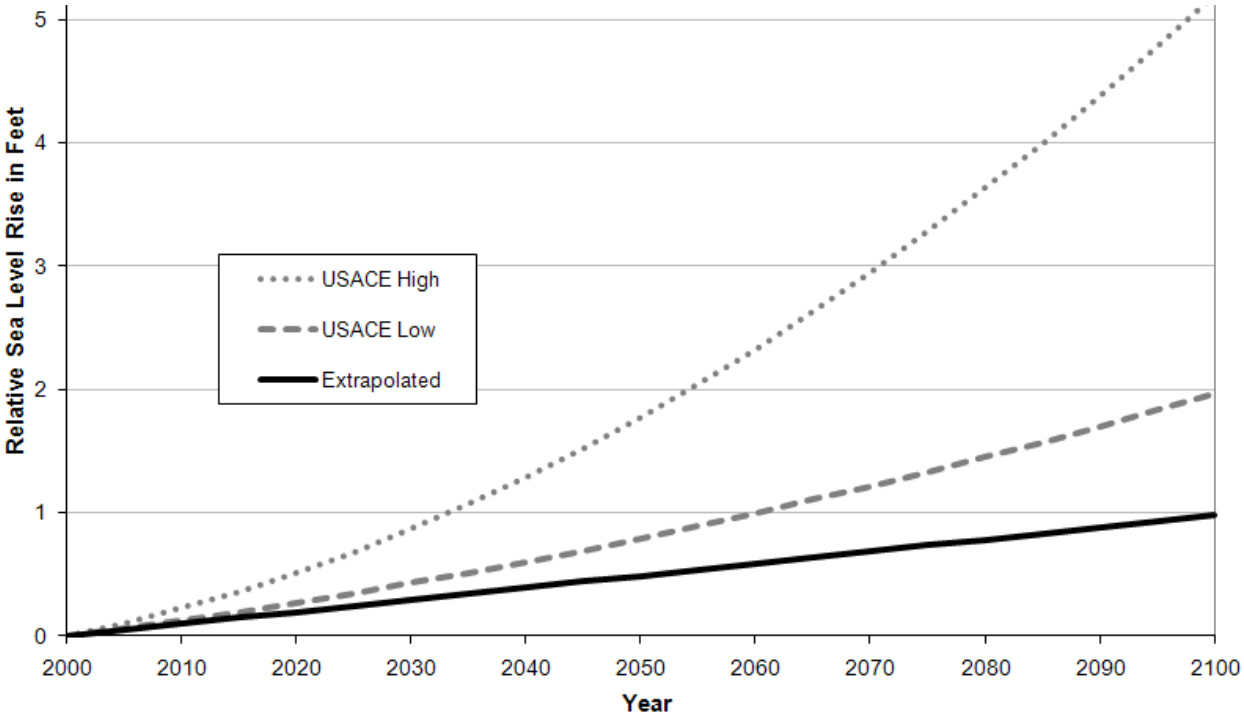


Figure 2.2.6-2
Sea Level Rise Predictions, 8735180 Dauphin Island, AL



2.2.7 Coastal Processes

Coastal processes evident in coastal Mississippi include waves, tides, littoral currents, and severe storm events. These natural factors are the primary ones affecting coastal morphology, but coastal processes are also influenced by water depth, coastal subsidence, and man-made structures.

The study area includes Mississippi Sound, which extends approximately 12 miles south of the coastline to where it intersects with the barrier islands. These barrier islands reduce the penetration of long swells arising out of the Gulf of Mexico, resulting in reduced wave energy within the Sound. The wave height is relatively low, with a mean tidal range of only 1.47 feet.

Man-made beaches along the Mississippi Coast extend for over 44 miles from Waveland in the west to Pascagoula in the east. Nearly all of these beaches are periodically replenished with sand. The Belle Fontaine headland in Jackson County is considered to be the only remaining natural beach on the Mississippi mainland coast. The beach is formed by natural sand deposition provided from longshore currents. However, as residents in the area have armored coastal areas to protect their homes, the natural sand source has been altered and the beach is now suffering from sand deficiency (Oivanki and Suhayda, 1994). Beaches serve as both an environmental resource and as an absorber of surge and wave energy. The Gulf Coast is generally considered to be a low-energy area except during the hurricane season. Natural changes to the coastline are episodic, associated with major storms and flooding events. High energy, short duration storm events, such as hurricanes and tropical storms, are particularly devastating to the Mississippi Coast where storm frequency is high and ground elevation is relatively low.

High waters and wave action associated with such severe storms are known to remove sand dunes from their given locations and displace large amounts of sand. Other less obvious properties and

processes that can have an impact on the coastline include wind induced currents, tidal flow, channel bathymetry, and residual tidal circulation. The natural coastal erosion rate for Mississippi is only about 2 inches per year, but may ebb and flow in many areas. The majority of groins, jetties, breakwaters, and seawalls along coastal Mississippi have since been repaired from Hurricane Katrina's destruction.

The unprecedented storm surge from Hurricane Katrina caused substantial losses to the barrier islands due to erosion. The vast majority of eroded land has not recovered, nor have the resources associated with that land. Dune systems were severely damaged or in some cases flattened. Interior forests were stripped of much of the undergrowth, which consists of shrub and herbaceous layers (MDMR, 2006). Many trees, dune grasses and herbaceous shrubs were killed and have not returned. The Mississippi Coastal Improvements Program (MsCIP), as part of the USACE, Mobile District, prepared a Comprehensive Plan & Integrated Programmatic EIS which included restoration of the barrier islands.

2.3 Biological Resources

2.3.1 Plankton and Algae

2.3.1.1 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. Peak plankton abundance occurs from spring through early fall (April-October) in estuaries and coastal areas and during the winter (November-March) in offshore areas. Plankton counts as high as 31,400 cells per liter have been recorded in the northeastern Gulf of Mexico. Chlorophyll *a* concentrations in the northern Gulf have been measured at concentrations ranging from 0.02 to 13.02 milligrams per cubic meter (mg/m^3) (USEPA, 1991 and MMS, 2006).

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, but there are likely more species present (Eleuterius, 1981). Greatest diversity of phytoplankton has been reported in areas affected by river discharges where both riverine and marine species occur (USEPA, 1991).

Phytoplankton densities are greatest where riverine waters override and spread out over the receiving oceanic waters, creating a nutrient-rich euphotic zone that is ideal for high rates of production (Ortner and Dagg, 2006). The early planktonic forms of many species of fish and invertebrates are dependent upon the neritic zone of the northern Gulf of Mexico (Pattillo et al., 1997). The neritic zone is defined as the oceanic zone extending from the mean low tide level to the edge of the continental shelf. The neritic zone encompasses the Mississippi Sound.

Blue-green algae and diatoms are the dominant microflora in marshes and seagrass beds in the 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 to 86 mg/m^2 depending on season and water conditions (Daehnick et al., 1992).

2.3.1.2 Zooplankton

Median zooplankton biomass has been measured on the continental shelf at 10.1 cubic centimeters (cm^3/L). Copepods are typically the dominant zooplankton form in this environment (Ortner and Dagg, 2006). 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). Harmful Algal Blooms (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). Recent identification of a higher number of bloom events may reflect better detection methods and more observers. Two species of algae (*Alexandrium monilata* and *Karenia breivs*) have caused HABs near the Mississippi Coast. *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. *A. monilata* blooms have impacted oysters, coquinas, mussels, gastropods, and fish (Anderson, 2007).

2.3.2 Benthic Invertebrates

The sediment and sand bottom present in Mississippi Sound near Pascagoula provides 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 recolonizing disturbed areas. Several species of polychaete worms were found to be dominant in parts of the project study area with this type of habitat (USEPA, 1991).

The benthic invertebrate community of Mississippi Sound near Pascagoula was assessed by the MDEQ during yearly sampling with a benthic dredge from 2001 through 2004 as part of the National Coastal Assessment (NCA) program (MDEQ, 2006b). The results of these surveys identified 226 species (3,466 individuals) from 18 major classes (12 phyla) of marine benthic invertebrates taken in the 17 sampling stations close to the navigation channel. A summary of the results is presented in Table 2.3.2-1. The surface sediments that serve as habitat for these species averaged 75 percent sand and 25 percent clay and silt. Sand concentrations at individual stations ranged from 19 percent to 98 percent (MDEQ, 2006b).

Table 2.3.2-1
Summary of Benthic Invertebrates Collected in Mississippi Sound from 2001 to 2004

Phylum	Class	Common Name	Number Collected	Percentage of Total
ANNELIDA			1645	47.46
Annellida	Polychaeta	Bristle worms	1624	46.86
Annelida	Oligochaeta	Oligochaetes	21	0.61
MOLLUSCA			965	27.84
Mollusca	Bivalvia	Oysters, clams, mussels	399	11.51
Mollusca	Scaphopoda	Tusk shells	10	0.29
Mollusca	Gastropoda	Snails, nudibranchs, sea slugs	556	16.04
ARTHROPODA			270	7.79

Arthropoda	Malacostraca	Crabs, shrimp, etc.	227	6.55
Arthropoda	Ostracoda	Seed shrimp	43	1.24
ECHINODERMATA			123	3.55
Echinodermata	Ophiuroidea	Brittle stars	120	3.46
Echinodermata	Echinoidea	Sea urchins, sand dollars, sea biscuits	2	0.06
Echinodermata	Holothuroidea	Sea cucumber	1	0.03
OTHER INVERTEBRATES			463	13.36
Nemertea		Ribbon worms	196	5.65
Cnidaria	Anthozoa	Anemones and coral	164	4.73
Phoronida		Horseshoe worms	49	1.41
Sipuncula	Sipunculida	Peanut worms	21	0.61
Hemichordata	Enteropneusta	Acorn worms	1	0.03
Platyhelminthes	Turbellaria	Flatworms	6	0.17
Bryozoa	Gymnolaemata	Moss animals	4	0.12
Chrodata	Leptocardii	Lancets	22	0.63

These results indicate that annelids (specifically polychaetes) constitute the largest percentage of the benthic community in this area for the combined invertebrates sampled. Four polychaete species accounted for nearly 30 percent of the benthic community: *Mediomastus ambiseta*, *Paraprionospio pinnata, Polygordius* sp., and *Owenia fusiformis*. All annelids, including the four dominant polychaete species, accounted for over 47 percent of the benthic community. Gastropods represented the next major group of benthic invertebrates, comprising over 16 percent of the benthic community. The gastropods, *Caecum pulchellum* and *C. glabrum,* were the dominant species, representing approximately 11 percent of the total benthic community. Other substantial contributions to the community were represented by bivalves, malacostracans, brittle stars, anemones, and ribbon worms.

These data are comparable to benthic data collected elsewhere in Mississippi Sound. 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).

In 2005, a comparison study was conducted near SRI to evaluate changes in the sediment characteristics and benthic community since an initial study in 1980 (USACE, 2005). A notable change was identified between the two surveys. Data from 12 stations were compared to define the sediment characteristics and the benthic invertebrate community. During 1980, at 2 of the 12 stations, the sand fraction contributed more than 50 percent of the particle size composition. In 2005, there was a pronounced shift in sediment composition: 9 of the 12 stations had a sand fraction contributing more than 50 percent of the particle size distribution. The benthic invertebrate community also displayed a notable change. In 1980, the average density at the 12 stations was 11,524 organisms/meter squared (m^2). In 2005, the average density was 1,224 organisms/m^2. The findings of the study indicated a dramatic decrease in taxa richness and macroinvertebrate density at all locations. The report concluded that the changes are indicative of the dynamic nature of shallow coastal areas of the Gulf of Mexico.

An evaluation of the benthic invertebrate community was conducted during the thin-layer demonstration program using two assessment methodologies to define changes in the benthic community as a result of dredged material disposal (USACE, 1999). The outcome of the study indicated that (1) the structure of the benthic community was recovering within 1 month and (2) that it

was comparable to that of the control area within as little as 5 months but could take up to 10 months to achieve a similar diversity.

2.3.3 Fish

The fish community in the vicinity of the Bayou Casotte Navigation Channel 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. Typically, these species 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).

The major fishery of the Pascagoula Harbor area is Gulf menhaden (Mississippi State University [MSU], 2007). 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. 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. 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).

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 fishes 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 a NCA program, the MDEQ conducted fishery trawl surveys in the Mississippi Sound from 2000 to 2004. These surveys identified 32 species of finfish near the Pascagoula Harbor Navigation Channel (Table 2.3.3-1).

Impacts from dredged material disposal on the fishery resource are a concern since the Gulf of Mexico fisheries resources are extremely valuable. As described earlier, the USACE performed a thin-layer dredged material study. During that study, impacts from several aspects of dredged material disposal were assessed through four investigations (USACE, 1999). The investigations included an evaluation

of feeding behavior response to increased turbidity and altered bottom conditions. The investigations also included an evaluation of physical damage to larval and post-larval fish from the sediment disposal operations. The outcome of the study indicated there were no substantial impacts to the fisheries resources.

Table 2.3.3.-1
Finfish Collected Near Pascagoula Harbor Navigation Channel

Scientific Name	Common Name
BONY FISH	
Anchoa hepsetus	Striped anchovy
Anchoa mitchilli	Bay anchovy
Arius felis	Hardhead catfish
Bagre marinus	Gafftopsail catfish
Bairdiella chrysoura	Silver perch
Caranx crysos	Blue runner
Centropristis sp.	Sea bass
Chaetodipterus faber	Atlantic spadefish
Chloroscombrus chrysurus	Atlantic bumper
Cynoscion arenarius	White trout
Dorosoma petenense	Threadfin shad
Etropus crossotus	Fringed flounder
Eucinostomus gula	Silver jenny
Harengula jaguana (pensacolae)	Scaled sardine
Lagodon rhomboides	Pinfish
Leiostomus xanthurus	Spot
Lutjanus campechanus	Red snapper
Lutjanus synagris	Lane snapper
Micropogonias undulatus	Atlantic croaker
Opisthonema oglinum	Atlantic thread herring
Orthopristis chrysoptera	Pigfish
Peprilus alepidotus	Harvestfish
Prionotus tribulus	Bighead searobin
Selene setapinnis	Atlantic moonfish
Selene vomer	Lookdown
Spoeroides parvus	Least puffer
Sphyraena guachancho	Guaguanche
Stellifer lanceolatus	Star drum
Symphurus plagiusa	Blackcheek tonguefish
Synodus foetens	Inshore lizardfish
SHARKS AND RAYS	
Dasyatis americana	Southern stingray
Dasyatis Sabina	Atlantic stingray

Source: MDEQ, 2004a.

2.3.4 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.). Bay scallop, Eastern oyster, and northern and Texas quahog clams (*Mercenaria mercenaria* and *M. mercenaria texana*) are among the bivalves also identified in estuaries around Mississippi's barrier islands (Cake, 1983).

All life stages of the bay scallop are estuarine and marine in nearshore, subtidal waters. They have been collected in waters ranging in depth from 0 to 33 feet down to a maximum of 59 feet, but are most abundant in waters 1 to 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 life stages. MDMR manages 17 natural oyster reefs (MDMR, 2011). The areal extent of oyster reefs in Mississippi is estimated at approximately 10,000 to 12,000 acres, of which approximately 7,400 acres are located in the western Mississippi Sound (MDWFP, 2005). Approximately 97 percent of the commercially harvested oysters in Mississippi come from the reefs in the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs. No actively managed oyster reefs are present in or near the Pascagoula Harbor Navigation Channel. Habitat at the channel is not suitable for the oyster.

The hard clam is an estuarine and marine species most often found in coastal bays from intertidal zones to water depths of 50 feet. They 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). Other abundant mollusks found in Mississippi Sound include various gastropods (snails, limpets, nudibranchs, and sea slugs) and cephalopods (octopods and squids).

2.3.5 Crustaceans

Three commercially important species of shrimp are found in Mississippi coastal waters: the brown shrimp *(Penaeus aztecus)*, the pink shrimp (*P. duorarum),* and the white shrimp *(P. setiferus).*

The life histories of these species are generally similar, although the time of spawning varies with each 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 known as a *nauplius*. Development to the post-larval stage takes several weeks. All of the developmental stages are found in the offshore plankton. The larvae are capable of little horizontal, directional movement and are unable to swim independently of the water currents. Larvae are photo tactic, moving up and down in the water column in response to light conditions. Shrimp migrate via currents from offshore waters to coastal bays during the last planktonic stage and enter estuarine nursery grounds as post-larvae. 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.

Post-larval and juvenile shrimp occupy shallow, brackish waters where they feed and grow. 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, 2007*).* Brown shrimp inhabit offshore waters ranging from 45 to 360 feet in depth. Mature pink shrimp inhabit deep offshore waters, and the highest concentrations occur in depths of 33 to 145 feet. 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).

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 shrimp harvest. The most productive seasons are those when water conditions are warm and brackish, i.e. in the spring (MDMR, 2007b).

The blue crab (*Callinectes sapidus*) is another important commercial and recreational 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. Eggs hatch near those areas and planktonic zoeal larvae are carried offshore for up to 1 month. 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).

Other crustaceans of abundance in Mississippi Sound include a variety of amphipods, isopods, shrimps, and crabs.

2.3.6 Hard Bottom Habitats

Hard bottom habitats serve as important spawning areas for fish species and support unique communities of marine organisms. According to the BOEM, "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 hard bottom habitats are located within Mississippi Sound. A small area of rock outcrop and consolidated features are 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).

2.3.7 Submerged Aquatic Vegetation (SAV)

Mississippi Sound encompasses an area of 1,850 square miles and contains approximately 30,000 acres of SAV (USEPA, 1999). Seagrasses represent the primary component of SAV. SAVs serve as nursery areas for fish and shellfish, such as shrimp and crabs, and as food for ducks. Approximately 2,000 acres of seagrass beds have been identified along coastal Mississippi (MDWFP, 2005). A seagrass evaluation was conducted to define the status and trends of seagrass and algae distribution in the northern Gulf of Mexico over the period 1940-2002 (Handley et al., 2007). The process used by

the investigation team included interpretation of 1:24,000-scale aerial photography, development of a classification system, confirmation of seagrass and algae presence by ground-truthing, and peer review of the outputs and documents. The original set of aerial photography was provided by NASA (National Aeronautics and Space Administration)-Stennis flights conducted in the fall of 1992. The process included evaluation of habitat in 6.6 feet or less of water. The vegetation documented in (the site formerly known as) disposal area 10 was ground-truthed in 1992 and identified as algae.

The majority of seagrasses in the State of Mississippi are found in the Gulf Islands National Seashores (GINS). Surveys of SAV on the north side of Horn Island show a decline in SAV from 1956 to 1992, recording 417 acres in 1956, 138 acres in 1987, and 14 acres in 1992 (Gulf of Mexico Fishery Management Council [GMFMC], 2004). More recent studies in 1992 and 1999 show an increase in SAV around Horn Island and Petit Bois Island. In the fall of 1992, 216 acres of SAV were identified around Horn Island and 190 acres around Petiti Bois Island. An updated survey in 1999 identified 578 acres of SAV around Horn Island and 425 acres around Petit Bois Island (Handley et al., 2007). A 2010 survey identified 974 acres of 'patchy' SAV adjacent to Horn Island and 541 acres of 'patchy' SAV adjacent to Petit Bois Island (Vittor, 2010).

Mississippi Sound is a shallow water environment that is routinely disturbed by storms. It has been well documented that sediments are suspended throughout the water column during storms. Although SAVs have declined since 1969, patches still persist north of the island where turbidity levels are higher than in the southern portions. Several species of seagrasses can be found in the Gulf of Mexico. They include shoalgrass (*Halodule beaudettei*), paddle grass (*Halophila decipiens*, *H. johnsonii*, *H. engelmanni*), manatee-grass (*Syringodium filiforme*, also known as *Cymodocea filiformis*), widgeon grass (*Ruppia maritima*), and turtle grass (*Thalassia testudinum*). Most seagrass meadows also include many species of epiphytic and drift algae (GMFMC, 2004).

The primary determinant of seagrass presence and productivity is light availability, which is determined by the interaction of water depth and water clarity. Seagrass presence is also influenced by sediment characteristics, salinity, wave energy, and water depth. Muddy substrates are generally preferred, but both shoalgrass and turtle-grass grow in sandy substrates. Paddle grass grows in highly polluted areas and nearly liquid mud. Low-energy, shallow water areas with restricted circulation are prime areas for seagrasses. Salinity tolerances vary from nearly freshwater to 45 ppt depending on the species (GMFMC, 2004). Turtle and manatee grasses tolerate salinities of 20-36 ppt. Shoalgrass is tolerant of harsher conditions (i.e. higher wave energy) than the other species, but prefers lower salinity (10-25 ppt). Widgeon grass prefers fresh and brackish waters. In most Gulf of Mexico estuaries, turbidity restricts seagrasses to water depths of less than 10 feet, although in very clear water areas (e.g., the Florida Keys) seagrasses can be found in depths as great as 100 feet (GMFMC, 2004). Substrate was considered a limiting factor for SAV communities in Mississippi Sound (Eleuterius, 1973). Most species were found in water less than 6 feet in depth.

Mississippi coast waters contain three submergent bed types: barrier island seagrass, widgeon grass, and American wildcelery (*Vallisneria americana*) beds. Barrier island seagrass beds originally contained shoal, turtle, and manatee grasses, although some species have become rare. The beds occur in the less turbid, moderately saline habitats on the north side of barrier islands (MDWFP, 2005). Widgeon grass beds occur in shallow, moderate-turbidity waters that are low in salinity. These beds occur in bays, along bayous, and in mudflats and barrier island ponds. The size and distribution of widgeon grass beds have varied over time due to damage from hurricanes. American wildcelery prefers freshwater or nearly freshwater and is typically found in the upper reaches of estuarine bayous and streams (MDWFP, 2005).

Seagrass meadows are highly productive and valuable habitats. They serve as important nurseries for numerous fish species, dampen wave action, reduce erosion, and promote water clarity while increasing bottom area and providing a surface upon which epiphytes and epibenthic organisms can

live. They also serve as a nursery, refuge, and food source for juvenile invertebrates and fish, as well as prime foraging habitat for adults of many species of fish (GMFMC, 2004).

Fish found in seagrass beds include permanent or seasonal residents, temporal migrants, and transients. Permanent residents include relatively sessile species, such as gobies, while seasonal residents include those fish and invertebrates that use the beds as nursery or spawning grounds (e.g., drums, snappers, and grunts). Throughout the Gulf, red drum and penaeid shrimp use seagrass meadows as nursery and foraging habitat. Large offshore or oceanic fish, such as mackerels and jacks, are also present in seagrass habitats from time to time (GMFMC, 2004).

Natural causes of SAV decline, such as disease, storm events, salinity fluctuation, and hypoxic (i.e. low oxygen) events, coupled with declining water quality caused by anthropogenic eutrophication (i.e. man-made overloading of nutrients) currently threaten the health of many SAV systems (Montague and Ley, 1993; Durako and Kuss, 1994; Olesen and Sand-Jensen, 1994; Zieman et al, 1999). These habitats provide vital refuges, feeding, resting, staging, and spawning grounds for a variety of species found in Mississippi Sound and also in the Gulf of Mexico. Past studies throughout the years have attributed anywhere from 50 percent to 90 percent of all marine species to utilize this vital habitat at some point in their life stage.

2.3.8 Marine Mammals

Twenty-nine marine mammal species (Table 2.3.8-1), including the West Indian manatee, have been sighted or are known to occur in the Gulf of Mexico (NOAA, 2003; MMS, 2000; and Texas Marine Mammal Stranding Network [TMMSN], 2007). The more common marine mammals found along the continental shelf of the northern Gulf include Atlantic bottlenose dolphins, Atlantic spotted dolphins, and spinner dolphins (MMS, 2000), which are routinely sighted in nearshore areas and along the Mississippi Sound barrier islands. Additionally, 16 of the species listed in Table 2.3.8-1 may occur in the Gulf throughout the year (MMS, 2000). Based on NMFS aerial surveys, the most commonly sighted groups along the upper continental slope of the north-central Gulf of Mexico were Risso's dolphin, Atlantic bottlenose dolphins, Atlantic spotted dolphins, pantropical spotted dolphins, striped, spinner, and clymene dolphins, sperm whales, dwarf and pygmy sperm whales, and short-finned pilot whales (Evans, 1999).

Table 2.3.8-1
Marine Mammals Occurring in the Gulf of Mexico

Scientific Name	Common Name
Balaenoptera acutorostrata	Minke whale
Balaenoptera borealis	Sei whale[a]
Balaenoptera edeni	Bryde's whale
Balaenoptera musculus	Blue whale[a]
Balaenoptera physalus	Fin 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 truncates	Atlantic bottlenose dolphin
Ziphius cavirostris	Cuvier's beaked whale

Sources: NOAA, 2003; BOEM, 2000; TMMSN, 2007; & NMFS, 2007a.

a Protected under the ESA of 1973 as Threatened or Endangered.

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. Other marine mammal species inhabitant of deeper waters off the continental shelf may occasionally be encountered in Mississippi Sound or farther out on the shelf, but these animals would be transients rather than residents.

Several species of marine mammals occurring in the Gulf are protected under the ESA, as amended, or under the MMPA. The western north Atlantic bottlenose dolphin populations found along the mid-Atlantic coast have been designated depleted under the MMPA and, therefore, are more critically managed in order to replenish these populations (NMFS, 2007a). The Gulf of Mexico population, however, is not considered to be at risk and is not managed as stringently as populations found along the mid-Atlantic coast. 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 Sound 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).

2.3.9 Marine and Coastal Birds

The GINS was established in 1971 and includes several diverse ecological communities which attract a variety of bird life. The Mississippi Sound barrier islands, including Horn Island and Petit Bois Island, make up part of the GINS. These two barrier islands consist of subtidal estuarine habitat, open beaches, pond and lagoon complex, freshwater and saltwater marshes, wooded inland, and seagrass beds and mollusk reef offshore (Gulf Ecological Management Site [GEMS], 2007; USGS, 2007). More than 280 species of birds have been identified within the GINS boundaries, including skimmers, plovers, terns, osprey, pelicans, and bald eagles (GEMS, 2007; NPS, 2007a). Between 1992 and 1994, bird research was conducted on Horn Island and found that up to 81 species of land-based migratory birds use the area as a stopover (University of Southern Mississippi [USM], 2007a).

2.3.9.1 Barrier Island Species

The Mississippi Sound barrier islands represent the primary marine and coastal bird habitat in the vicinity of the navigation channel. These islands provide feeding, resting, and wintering habitat for numerous resident and migratory bird species, such as the brown pelican, white pelican, and cormorants. Horn Island is considered a rookery for the least tern, black skimmer, bald eagle, and osprey. Petit Bois Island is a rookery for the least and sandwich tern, black skimmer, Louisiana heron, and osprey (GEMS, 2007). Additionally, Horn, Petit Bois, and Round Islands have been designated critical habitat for the wintering piping plover (USFWS, 66 Fed. Reg. 36038 - 36086 [July 10, 2001]).

The brown pelican (*Pelecanus occidentalis*) typically is found nearshore and feeds mostly in shallow estuarine waters. The American white pelican *(Pelecanus erythrorhynchos)* often forages in shallow water and usually nests in open areas, though it may also use dredged material or natural islands. The double-crested cormorant (*Phalacrocorax auritus)* habitat includes marine islands, coastal bays, and seacoasts; usually within sight of land. The least tern (*Sterna antillarum*) requires open sandy coastal beaches, and river sandbars for nesting. It nests in scrapes in sand above ordinary tides and breeds during the summer months. The black skimmer (*Rynchops niger*) 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, 2007). The bald eagle (*Haliaeetus leucocephalus)* 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. An osprey's *(Pandion haliaetus)* nest can be found on living and dead trees, but also on several different types of man-made structures. The Louisiana heron *(Egretta tricolor)* 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 island (NatureServe, 2007).

2.3.9.2 Mississippi Sandhill Crane National Wildlife Refuge

The Mississippi Sandhill Crane National Wildlife Refuge (MSCNWR) is approximately 30 miles west of Pascagoula. The Mississippi sandhill crane (*Grus canadensis pulla*) is non-migratory and is designated as a Federal endangered species. The Mississippi sandhill crane is found only on and adjacent to the MSCNWR. This refuge provides protection and allows management of the Mississippi sandhill crane, as well as preserving wet pine savanna communities (USFWS, 1992).

2.3.10 Threatened and Endangered Species

Several species of threatened and endangered (T&E) animals may occur in the vicinity of the project (Table 2.3.10-1). Several other T&E species are known from marine habitats in the Gulf of Mexico. These species are blue whale (*Balaenoptera musculus*), finback whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), Sei whale (*Balaenoptera borealis*), sperm whale (*Physeter macrocephalus*), loggerhead sea turtle (*Caretta caretta*), green sea turtle (*Chelonia mydas)* and Kemp's ridley sea turtle (*Lepidochelys kempii*). These T&E marine species might be occasional visitors to the project area. Whale species that may occur as transient within the project study area include finback whale and humpback. The MSMNS reports that both whales are known to visit the Gulf of Mexico (MSMNS, 2007). The largest numbers of finback whales are found 25 miles or more from shore. The humpback whales prefer coastal waters and sometimes frequent inshore areas, such as bays. Their range occurs throughout the world's oceans from the subtropics to high latitudes, but they are rarely seen in the Gulf of Mexico. They spend their winters in the tropical and subtropical waters near islands and coasts, but spend summers in temperate and sub-polar waters (NatureServe, 2007).

Table 2.3.10-1
USFWS Sensitive Species that May Occur in the Vicinity of the Proposed Action

Scientific Name	*Common Name*	*Federal Status*
Plants		
Isoetes louisianensis	Louisiana quillwort	Endangered
Mammals		
Trichechus manatus	West Indian manatee	Threatened
Birds		
Charadrius melodus	Piping plover	Endangered
Haliaeetus leucocephalus	Bald eagle	Bald and Golden Eagle Protection Act (BGEPA)
Picoides borealis	Red-cockaded woodpecker	Endangered
Grus canadensis pulla	Mississippi sandhill crane	Endangered
Calidris canutus rufa	Red knot	Threatened
Amphibians and Reptiles		
Caretta caretta	Loggerhead sea turtle	Threatened
Dermochelys coriacea	Leatherback sea turtle	Endangered
Chelonia mydas	Green sea turtle	Threatened
Lepidochelys kempii	Kemp's Ridley sea turtle	Endangered
Pseudemys alabamensis	Alabama red-bellied turtle	Endangered
Graptemys flavimaculata	Yellow-blotched map turtle	Threatened
Pituophis melanoleucus ssp.lodingi	Black pine snake	Threatened
Gopherus polyphemus	Gopher tortoise	Threatened
Rana capito sevosa	Mississippi gopher frog	Endangered
Fish		
Acipenser oxyrinchus desotoi	Atlantic sturgeon (Gulf ssp.)	Threatened
Percina aurora	Pearl darter	Threatened

Sources: USFWS, 2017; Mississippi Museum of Natural Science (MSMNS), 2007.

2.3.10.1 Louisiana Quillwort

Louisiana quillwort (*I. louisianensis*) is a primitive seedless wetland plant with a grass-like appearance, although it is actually more closely related to ferns (Figure 2.3.10.1-1). It has many simple, hollow leaves 1-2 inches wide and up to 24 inches long. Quillworts reproduce by producing spores in special structures embedded in the leaves. The Louisiana quillwort is restricted to gravel bars and sandy soils in or near shallow blackwater creeks and overflow channels in narrow riparian woodlands or bayheads in pine flatwoods and upland longleaf pine vegetative communities (USFWS, 1996). This species has been documented in the Pleistocene High Terraces ecoregion in southern Mississippi. Louisiana quillwort was discovered in southeastern Louisiana in 1972. In 1996, it was known from a handful of sites in southeastern Louisiana and in two Mississippi counties, Jackson and Perry (USFWS, 1996). Recent survey work however, has discovered this plant in more than 50 locations spread over 10 Mississippi counties (Natureserve, 2007).

Louisiana quillwort is listed as endangered by the USFWS. Threats to quillwort populations include timber harvest, sand and gravel mining, construction, and other activities with potential to alter the hydrology of small stream habitats (Natureserve, 2007). Louisiana quillwort is adapted to dynamic stream ecosystems in which natural processes scour and redeposit individual plants and spores on constantly changing gravel bars and sandy streambanks. This species has not been observed to grow on silt substrates even when other habitat factors are appropriate (USFWS, 1996).

Figure 2.3.10.1-1
Louisiana quillwort

2.3.10.2 Manatee

The West Indian or Florida manatee (*T. manatus*) was listed as an endangered species in 1967 (under a law that preceded the ESA) throughout all or a significant portion of its range (USFWS, 2001g). The manatee also is protected at the Federal level under the MMPA. However, due to species recovery, the West Indian Manatee was reclassified from 'endangered' to 'threatened' on May 5, 2017.

The manatee (sometimes called sea cow) is found primarily along the coast of Florida. Most adult manatees are about 10 feet long and weigh 800 to 1,200 pounds, although some larger than 12 feet and weighing as much as 3,500 pounds have been recorded (Figure 2.3.10.2-1). These "gentle giants" have a tough, wrinkled brown-to-gray skin that is continuously being sloughed off. Hair is distributed sparsely over the body. With stiff whiskers around its mouth, the manatee's face looks like a walrus without tusks.

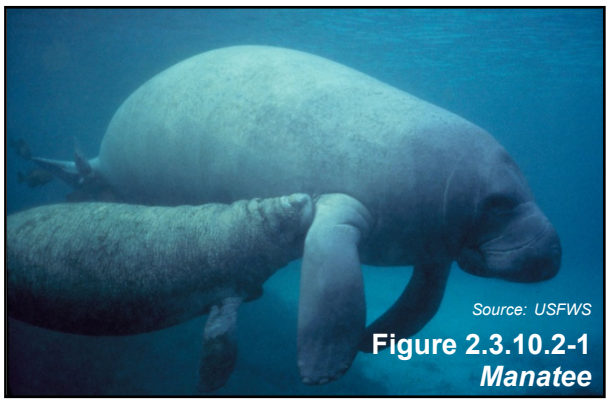


Figure 2.3.10.2-1
Manatee

Manatees spend their lives moving between freshwater, brackish, and saltwater environments. They prefer large, slow-moving rivers, river mouths, and shallow coastal areas, such as coves and bays. Great distances may be covered as the animals migrate between winter and summer grounds. During the winter, the U.S. manatee population confines itself to the coastal waters of the southern half of peninsular Florida and to springs and warm water outfalls as far north as southeast Georgia. During summer months, manatees may migrate as far north as coastal Virginia on the east coast and the Louisiana coast on the Gulf of Mexico. Manatees are known to migrate through the study area, and several have been rescued in the study area during cold weather outbreaks. In fact, one or more manatees have been seen annually in Mississippi waters each year for the past decade.

2.3.10.3 Piping Plover

The piping plover *(C. melodus)* is a small, stocky, sandy-colored bird resembling a sandpiper (Figure 2.3.10.3-1). The adult has yellow-orange legs, a black band across the forehead from eye to eye, and a black ring around the base of its neck. Like other plovers, it runs in short starts and stops. When still, the piping plover blends into the pale background of open, sandy habitat on outer beaches where it feeds and nests. The bird's name derives from its call notes, plaintive bell-like whistles often heard before the birds are seen.

Source: USFWS

Figure 2.3.10.3-1
Piping Plover

The piping plover is listed as a federally endangered species within the watershed of the Gulf Coast as listed in the FR, December 11, 1985. The piping plover breeds on sandy or pebble coastal beaches of Newfoundland and southeastern Quebec to North Carolina. Decline in piping plover populations has been linked to loss of breeding habitat. Shoreline development, river flow alteration, river channelization, and reservoir construction have all led to loss of breeding habitat. The piping plover is a federally threatened and state endangered shorebird. All piping plovers are considered threatened species under the ESA when on their wintering grounds. The piping plover winters along the Gulf Coast but does not nest in Mississippi. The Mississippi Natural Heritage Program database indicates three over-wintering sightings of piping plovers: one along the beaches of Gulfport, one on Deer Island, and one on Ship Island.

Several factors are contributing to the decline of the piping plover along the Atlantic Coast. Commercial, residential, and recreational development have decreased the amount of coastal habitat available for piping plovers to nest and feed. Human disturbance often curtails breeding success. Foot and vehicular traffic may crush nests or young. Excessive disturbance may cause the parents to desert the nest, exposing eggs or chicks to the summer sun and predators. Interruption of feeding may stress juvenile birds during critical periods in their development. Pets, especially dogs, may harass the birds. Developments near beaches provide food that attracts increased numbers of predators, such as raccoons, skunks, and foxes. Domestic and feral cats are also very efficient predators of plover eggs and chicks. Storm tides may inundate nests.

Piping plovers winter in coastal areas of the U.S. from North Carolina to Texas. Piping plovers begin arriving on the wintering grounds in July, with some late-nesting birds arriving in September. Behavioral observations of piping plovers on the wintering grounds suggest that they spend the majority of their time foraging (Nicholls and Baldassarre 1990). The international piping plover winter censuses of 1991 and 1996 located only 63 percent and 42 percent of the estimated number of breeding birds, respectively (Haig and Plissner 1992; Haig and Plissner 1993). Of the birds located on the U.S. wintering grounds during these two censuses, 89 percent were found on the Gulf Coast and 8 percent were found on the Atlantic Coast. Approximately 35 percent of the piping plover's total breeding population winters on the Gulf Coast between Florida and Texas) (NatureServe, 2007; USFWS 2011). The USFWS has designated the Gulf of Mexico coastline, Horn Island, Petit Bois Island, and Round Island as critical habitat for the wintering piping plovers (Figure 2.3.10.4-2 ; USFWS, 2011). Table 2.3.10.4-1 identifies piping plover critical habitat in the region.

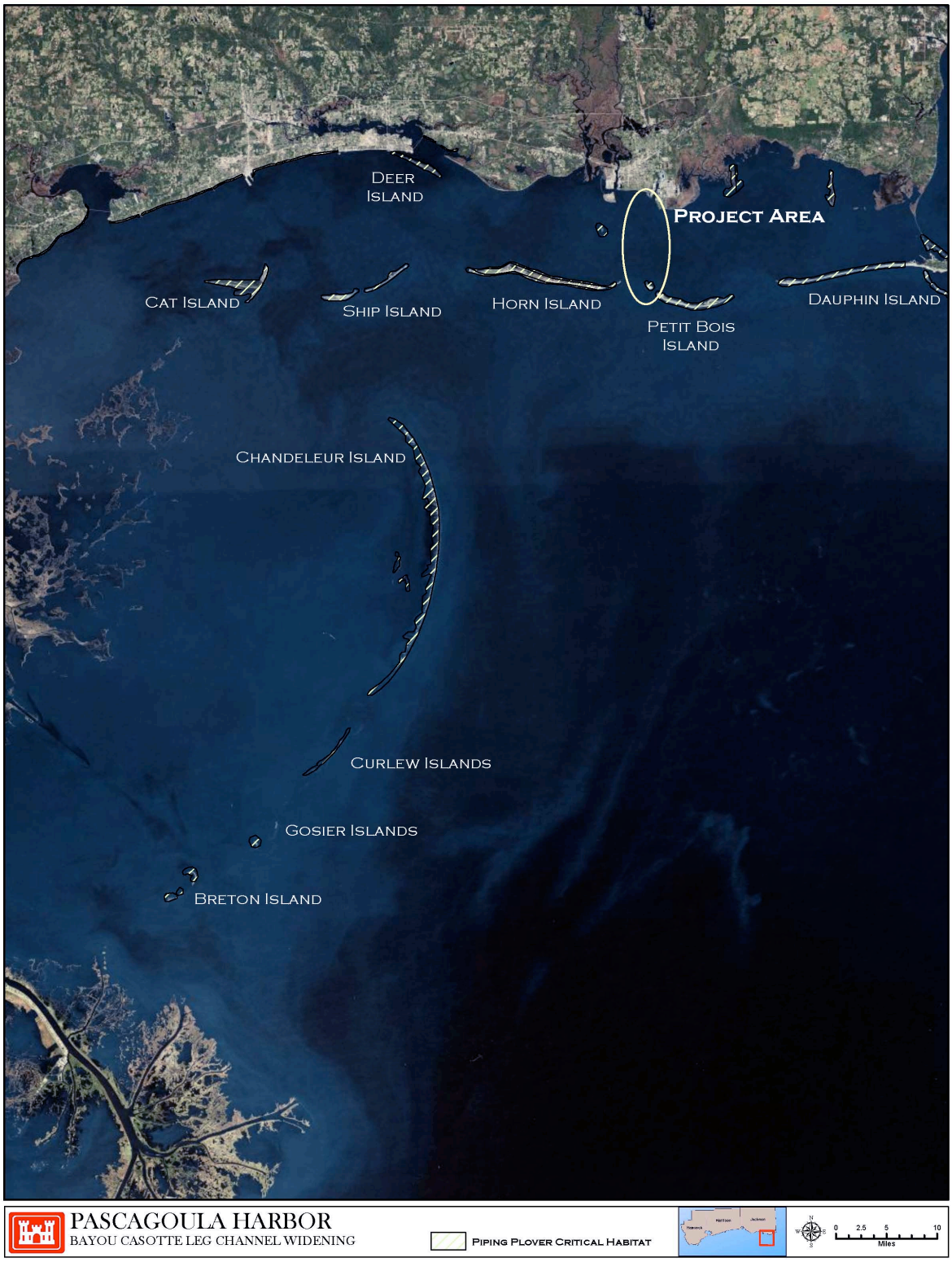
Table 2.3.10.4-1
Piping Plover Critical Habitat in Mississippi

Unit	Description
MS-1	Lakeshore through Bay St. Louis. 101 acres in Hancock County. This unit extends from the north side of Bryan Bayou outlet and includes the shore of the Mississippi Sound following the shoreline northeast approximately 9.3 miles and ending at the southeast side of the Bay Waveland Yacht Club. The landward boundary of this unit follows the Gulf side of South and North Beach Boulevard and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-2	Henderson Point. 84 acres in Harrison County. This unit extends from 0.12 miles west of the intersection of 3rd Avenue and Front Street and includes the shore of the Mississippi Sound following the shoreline northeast approximately 2.7 miles to the west side of Pass Christian Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-3	Pass Christian. 190 acres in Harrison County. This unit extends from the east side of Pass Christian Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 6.5 miles to the west side of Long Beach Pier and Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-4	Long Beach. 94 acres in Harrison County. This unit extends from the east side of Long Beach Pier and Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 2.7 miles to the west side of Gulfport Harbor. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-5	Gulfport. 96 acres in Harrison County. This unit extends from the east side of Gulfport Harbor and includes the shore of the Mississippi Sound following the shoreline northeast approximately 3.0 miles to the west side of the groin at the southern terminus of Courthouse Road, Mississippi City, Mississippi. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-6	Mississippi City. 153 acres in Harrison County. This unit extends from the east side of the groin at the southern terminus of Courthouse Road, Mississippi City, Mississippi, and includes the shore of the Mississippi Sound following the shoreline northeast approximately 4.9 miles to the west side of President Casino. The landward boundary of this unit follows the Gulf side of U.S. Highway 90 and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-7	Beauvoir in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-8	Biloxi West in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-9	Biloxi East in Harrison County. Excluded. The proposed rule included this unit, but it was deleted for lack of evidence of regular use by piping plovers.
MS-10	Ocean Springs West. 27 acres in Jackson County. This unit extends from U.S. Highway 90 and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.2 miles to the Ocean Springs Harbor inlet. The landward boundary of this unit follows the Bay side of Front Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-11	Ocean Springs East. 17 acres in Jackson County. This unit extends from the east side of Weeks Bayou and includes the shore of Biloxi Bay following the shoreline southeast approximately 1.1 miles to Halstead Bayou. The landward boundary of this unit follows the Bay side of East Beach Drive and the seaward boundary is MLLW. The shoreline of this unit is privately owned.
MS-12	Deer Island. 479 acres in Harrison County. This unit includes all of Deer Island, where primary constituent elements (PCEs) occur to the MLLW. Deer Island is privately owned.
MS-13	Round Island. 67 acres in Jackson County. This unit includes all of Round Island to the MLLW and is privately owned.
MS-14	Mississippi Barrier Islands. 7,828 acres in Harrison and Jackson Counties. This unit includes all of Cat, East and West Ship, Horn, and Petit Bois Islands where PCEs occur to MLLW. Cat Island is privately owned, and the remaining islands are part of the GINS.

Unit	Description
MS-15	North and South Rigolets. 393 acres in Jackson County, Mississippi, and 30 acres in Mobile County, Alabama. This unit extends from the southwestern tip of South Rigolets Island and includes the shore of Point Aux Chenes Bay, the Mississippi Sound, and Grand Bay following the shoreline east around the western tip, then north to the south side of South Rigolets Bayou; then from the north side of South Rigolets Bayou (the southeastern corner of North Rigolets Island) north to the northeastern most point of North Rigolets Island. This shoreline is bounded on the seaward side by MLLW and on the landward side to where densely vegetated habitat, not used by the piping plover, begins and where the constituent elements no longer occur. Approximately 2.7 miles are in Mississippi and 1.8 miles are in Alabama. Almost half the Mississippi shoreline length is in the Grand Bay National Wildlife Refuge (GBNWR).

Source: USFWS

Figure 2.3.10.4-2
Piping Plover Critical Habitat



2.3.10.4 Bald Eagle

The bald eagle *(Haliaeetus leucocephalus)*, our national bird, is the only eagle unique to North America (Figure 2.3.10.4-1). The bald eagle's scientific name signifies a sea *(halo)* eagle *(aeetos)* with a white *(leukos)* head. At one time, the word "bald" meant "white," not hairless. Bald eagles are found throughout most of North America, from Alaska and Canada to northern Mexico. About half of the world's 70,000 bald eagles live in Alaska. Combined with British Columbia's population of about 20,000, the northwest coast of North America is by far their greatest stronghold for bald eagles. They flourish here in part because of the salmon. Dead or dying fish are an important food source for all bald eagles.

Eagles are a member of the *Accipitridae* family, which also includes hawks, kites, and old-world vultures. Scientists loosely divide eagles into four groups based on their physical characteristics and behavior. The bald eagle is a sea or fish eagle. There are two subspecies of bald eagles. The "southern" bald eagle, *Haliaeetus leucocephalus leucocephalus,* is found in the Gulf States from Texas and Baja California across to South Carolina and Florida, south of 40 degrees north latitude. The "northern" bald eagle, *Haliaeetus leucocephalus alascanus,* is found north of 40 degrees north latitude across the entire continent. The largest numbers of northern bald eagles are in the Northwest, especially in Alaska.

Figure 2.3.10.4-1
Bald Eagle

The "northern" bald eagle is slightly larger than the "southern" bald eagle. Studies have shown that "northern" bald eagles fly into the southern states and Mexico, and the "southern" bald eagles fly north into Canada. Because of these findings, the subspecies of "northern" and "southern" bald eagles has been discontinued in recent literature. Bald eagles were officially declared an endangered species in 1967 in all areas of the U.S. south of the 40th parallel, under a law that preceded the ESA. Until 1995, the bald eagle had been listed as endangered under the ESA in 43 of the 48 lower states, and listed as threatened in Wisconsin, Minnesota, Michigan, Washington and Oregon. In July of 1995, the USFWS upgraded the status of bald eagles in the lower 48 states to "threatened." On June 28, 2007, the USDOI took the American bald eagle off the endangered species list. The bald eagle will still be protected by the Migratory Bird Treaty Act and the BGEPA. The BGEPA prohibits the take, transport, sale, barter, trade, import and export, and possession of eagles, making it illegal for anyone to collect eagles and eagle parts, nests, or eggs without a permit. Native Americans are able to possess these emblems which are traditional in their culture.

Breeding habitat for the bald eagle typically occurs within 2.5 miles of coastal areas, bays, rivers, lakes, or other bodies of water where fish, waterfowl, and seabirds (primary food sources) are prevalent. Bald eagles avoid areas with extensive human activity, such as boat traffic and pedestrians, and development.

2.3.10.5 Red-Cockaded Woodpecker

Red-cockaded woodpeckers (*P. borealis*) are small to medium-sized woodpeckers 8 to 16 inches long, with a 20 to 24 inch wingspan (Figure 2.3.10.5-1). White spots on black feathers give the bird a “ladder-back” appearance. Red-cockaded woodpeckers have a white cheek patch on either side of the head,

as well as a black cap. Male woodpeckers have thin red streaks on the cheeks that are barely visible (Natureserve 2000). Red-cockaded woodpeckers nest and forage in mature pine stands frequently burned to promote an open understory and thick herbaceous layer. Research indicates that red-cockaded woodpeckers excavate nest cavities in pines 60 years or older (USFWS 1998a). The birds were once abundant in pinelands throughout the southeastern U.S., but fire suppression, subsequent hardwood encroachment, conversion to short-rotation pine plantations, and development have eliminated most suitable habitat.

The red-cockaded woodpecker is listed by the USFWS as endangered throughout its range. Scattered populations exist from southeastern Oklahoma to southern Virginia, south to Florida and eastern Texas. In Mississippi, red-cockaded woodpeckers have been reported in Harrison and Jackson Counties.

Figure 2.3.10.5-1
Red-Cockaded

2.3.10.6 Mississippi Sandhill Crane

Mississippi sandhill crane (*G. canadensis pulla*) is a large wading bird similar in appearance to herons and other cranes (Figure 2.3.10.6-1). Sandhill cranes have gray feathers with long legs and neck. Adult sandhill cranes have a red patch on the forehead (USFWS 2001d). The Mississippi sandhill crane is a non-migratory subspecies of sandhill crane found only in Jackson County, Mississippi. Most sandhill cranes are migratory, but there are three recognized subspecies that do not migrate: Florida sandhill crane (*G. canadensis pratensis*), Cuban sandhill crane (*G. canadensis nesiotes*), and Mississippi sandhill crane. Approximately 100 to 110 Mississippi sandhill cranes existed in the wild in 2012.

An USFWS captive breeding program has been successful in reintroducing several breeding cranes to the MSCNWR. These cranes are found in wet and dry open forests and savannahs with longleaf pine, slash pine, and cypress (*T. ascendens*). Mississippi sandhill cranes feed on live prey, such as amphibians, worms and insects. At certain times of the year, the cranes also eat plant foods, such as corn, roots, tubers, and pecans. Mississippi sandhill cranes reproduce slowly, raising only one chick per year. Hatching success is low, and very few young birds have been observed. Low population levels and inbreeding might be responsible for low hatching success and a high rate of disease in Mississippi sandhill cranes (USFWS 2001d).


Source: USFWS

Figure 2.3.10.6-1
Mississippi Sandhill Crane

Critical habitat for the Mississippi sandhill crane covers about 26,000 acres in Jackson County. The main threat to the survival of this subspecies is loss and fragmentation of habitat. Conversion of open forests to dense pine plantation, fire suppression, encroachment of residential and commercial developments, roads that facilitate access to and fragment crane habitat, and chemical spraying on roadsides all contribute to population decline (Natureserve 2001e, USFWS 2001d). These cranes are territorial when nesting. Nests can be separated by a half mile or more. If the Mississippi sandhill crane population recovers, more suitable habitat will be needed so that adult cranes have space to hatch and rear young. Habitat maintenance, which requires occasional fire -either prescribed or wild- is increasingly difficult with the encroachment of suburbia and urban areas on crane habitat. The distribution of the Mississippi sandhill crane is restricted to an area in southern Jackson County, extending from the Pascagoula River west to the Jackson County line, south to Simmons Bayou, north to a latitude about 4 miles north of Vancleave, Mississippi. A portion of this area has been designated the MSCNWR (NatureServe, 2007).

2.3.10.7 Red knot

Red knots (*C. cantus rufa*) a species of sandpiper shorebird, have been observed wintering on the majority of the barrier islands, especially Cat Island and Petit Bois Island in few numbers. Similar wintering habitat requirements to the piping plover exist for red knots. There are six (6) recognized subspecies of red knots (*C. canutus*), and on December 11, 2014, the USFWS published a final rule in the Federal Register listing the rufa subspecies of red knot (*Calidris canutus rufa*) as a threatened species under the Endangered Species Act. The USFWS has determined that the rufa red knot is threatened due to loss of both breeding and nonbreeding habitat; potential for disruption of natural predator cycles on the breeding grounds; reduced prey availability throughout the nonbreeding range; and increasing frequency and severity of asynchronies (“mismatches”) in the timing of the birds’ annual migratory cycle relative to favorable food and weather conditions. Main threats to the rufa red knot in the United States include: reduced forage base at the Delaware Bay migration stopover; decreased habitat availability from beach erosion, sea level rise, and shoreline stabilization in Delaware Bay; reduction in or elimination of forage due to shoreline stabilization, hardening, dredging, beach replenishment, and beach nourishment in Massachusetts, North Carolina, and Florida; and beach raking which diminishes red knot habitat suitability. Critical habitat has not been proposed or designated for the red knot at this time.


Source: USFWS

Figure 2.3.10.7-1
Red knot

2.3.10.8 Loggerhead Turtle

The loggerhead turtle (*C. caretta*) was listed as threatened throughout its range on July 28, 1978 [43 Code of Federal Regulation (CFR) § 82808], and its status has not changed (Figure 2.3.10.8-1). The loggerhead sea turtle is widely distributed throughout its range and may be found hundreds of miles out to sea as well as in inshore areas, such as bays, lagoons, salt marshes, creeks, ship

channels, and the mouths of large rivers (USACE, Mobile District 2000). Loggerheads are known to migrate over long distances, with tagged specimens having been recaptured 1,200 to 1,500 miles from the point of release. Loggerheads are seen annually inshore in Mississippi Sound, but are more commonly seen offshore in the proximity of oil rigs. Most recent evidence suggests that the number of nesting females in South Carolina and Georgia may be declining, while the number of nesting females in Florida appears to be stable. Until the 1970s, loggerhead turtles were commercially harvested for their meat, eggs, leather, and fat. Its meat and leather are not as valuable as the green sea turtle, and its shell is of less value than the hawksbill. However, in places where regulations are not enforced, the harvest of turtle meat and eggs remains a problem. Because of their feeding behavior and their habit of wintering in shallow waters, loggerheads, along with Kemp's Ridley sea turtles, are more likely to be caught in large shrimp trawl nets and drown. Today, turtle excluder devices (TEDs) pulled by shrimp boats help reduce mortality from net entanglement by allowing turtles to escape from the nets. However, loggerhead turtles are hooked by recreational fishermen offshore near oil rigs and are frequently injured by being struck by boats and boat propellers.

Loggerheads are capable of living in a variety of environments, such as in brackish waters of coastal lagoons and river mouths. During the winter, they may remain dormant, buried in the mud at the bottom of sounds, bays, and estuaries. The southeastern U.S. supports one of the largest aggregations of nesting loggerheads in the world, especially peninsular Florida, with additional nesting beaches occurring in Georgia, South and North Carolina, the Florida panhandle, and Alabama (Ehrhart et al., 2003). No reliable estimates for loggerhead nesting exist for Mississippi. However, past aerial surveys and incidental encounters have recorded nesting activity on the GINS and it is believed that the majority of nesting happens on the Mississippi barrier islands. Prior to 2012, the last scientifically documented loggerhead nest on the Mississippi mainland occurred in 1990 (Hoggard, 1991), even though a nest was detected in 2008. In 2012, one suspected and four confirmed loggerhead nests were observed and monitored on the Mississippi mainland.

In July 2014, the USFWS designated approximately 685 miles of coastal beach habitat as important for the recovery of the threatened Northwest Atlantic Ocean population of loggerhead sea turtles, as directed by the ESA. The terrestrial critical habitat areas include 88 nesting beaches in coastal counties located in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. These beaches account for 48 percent of an estimated 1,531 miles of coastal beach shoreline and about 84 percent of the documented nesting within these six states. Areas designated as critical habitat in Mississippi nearest the project area include Horn Island and Petit Bois Island. However the proposed action does not include impacting these areas, and USFWS has stated no further coordination actions would be required.

Source: USFWS

Figure 2.3.10.8-1
Loggerhead Sea Turtle

2.3.10.9 Leatherback Sea Turtle

The leatherback (*Dermochelys coriacea)* is the largest turtle and the largest living reptile in the world (Figure 2.3.10.9-1). Mature males and females can be as long as six and a half feet and weigh almost 2,000 lbs. The leatherback is the only sea turtle that lacks a hard, bony shell. A leatherback's carapace is approximately 1.5 inches thick and consists of leathery, oil saturated connective tissue overlaying loosely interlocking dermal bones. The carapace has seven longitudinal ridges and tapers to a blunt point. Adult leatherbacks are primarily black with a pinkish white mottled ventral surface and pale white and pink spotting on the top of the head. The front flippers lack claws and scales and are proportionally

longer than in other sea turtles; back flippers are paddle-shaped. The ridged carapace and large flippers are characteristics that make the leatherback uniquely equipped for long distance foraging migrations. Leatherbacks lack the crushing, chewing plates characteristic of sea turtles that feed on hard-bodied prey. Instead, they have pointed tooth-like cusps and sharp edged jaws perfectly adapted for a diet of soft-bodied pelagic (open ocean) prey, such as jellyfish and salps. A leatherback's mouth and throat also have backward-pointing spines that help retain such gelatinous prey.

Female leatherbacks lay clutches of approximately 100 eggs on sandy, tropical beaches. Females nest several times during a nesting season, typically at 8 to 12 day intervals. After 60 to 65 days, leatherback hatchlings with white striping along the ridges of their backs and on the margins of the flippers emerge from the nest. Leatherback hatchlings are approximately 2 to 3 inches in length, with fore flippers as long as their bodies, and weigh approximately 1.4 to 1.8 ounces. Leatherbacks are commonly known as pelagic animals, but also forage in coastal waters. Leatherbacks are the most migratory and wide ranging of sea turtle species. Thermoregulatory adaptations, such as a counter-current heat exchange system, high oil content, and large body size, allow them to maintain a core body temperature higher than that of the surrounding water, thereby allowing them to tolerate colder water temperatures. Nesting female leatherbacks tagged in French Guiana have been found along the east coast of North America as far north as Newfoundland. Atlantic Canada supports one of the largest seasonal foraging populations of leatherbacks in the Atlantic. Leatherbacks tagged with satellite transmitters at sea off Nova Scotia were tracked to waters adjacent to nesting beaches along the northeast coast of South American, the Antilles, Panama and Costa Rica. Leatherbacks mate in the waters adjacent to nesting beaches and along migratory corridors. After nesting, female leatherbacks migrate from tropical waters to more temperate latitudes, which support high densities of jellyfish prey in the summer. Leatherback turtle nesting grounds are located around the world, with the largest remaining nesting assemblages found on the coasts of northern South America and West Africa. The U.S. Caribbean, primarily Puerto Rico and the U.S. Virgin Islands, and southeast Florida support minor nesting colonies, but represent the most significant nesting activity within the U.S. Though leatherback nesting is concentrated in the western Caribbean, the turtles also nest along the shores of the Gulf of Mexico. Adult leatherbacks are capable of tolerating a wide range of water temperatures, and have been sighted along the entire continental coast of the U.S. as far north as the Gulf of Maine and south to Florida.

Leatherback turtles face threats on both nesting beaches and in the marine environment. The greatest causes of decline and the continuing primary threats to leatherbacks worldwide are long-term harvest and incidental capture in fishing gear. Harvest of eggs and adults occurs on nesting beaches while juveniles and adults are harvested on feeding grounds. Incidental capture primarily occurs in gillnets, but also in trawls, traps and pots, longlines, and dredges. Together these threats are serious ongoing sources of mortality that adversely affect the species' recovery.

Source: USFWS

Figure 2.3.10.9-1
Leatherback Sea Turtle

2.3.10.10 Green Sea Turtle

The green sea turtle (C. mydas) was listed on July 28, 1978. The breeding population off Florida and the Pacific coast of Mexico is listed as endangered while all others are threatened (NOAA 2001).

Green sea turtles range throughout the Atlantic, Pacific, and Indian Oceans, primarily in tropical regions and shallow waters (except during migration), inside reefs, bays, and inlets. The green sea turtles are attracted to lagoons and shoals with abundant marine grass and algae on which the turtles feed. Green sea turtles have been observed in Mississippi Sound (Figure 2.3.10.10-1); several green turtles have been incidentally captured at Mississippi fishing piers and rehabilitated. The turtles are not known to nest on the Mississippi coast or barrier islands, but might be attracted to seagrass beds as a food source in nearshore waters.

However, because it has been observed in Alabama, green sea turtle nesting is possible in Mississippi. The principal U. S. nesting areas are in eastern Florida, with nesting occurring from March through October in the Caribbean-Gulf of Mexico region. They nest on beaches with high energy and deep sand, usually islands, but they also nest on mainlands. They feed most commonly in areas of shallow, low-energy water where submerged vegetation is abundant (NatureServe, 2007).

Exploitation of green sea turtle nesting grounds either by human interference or pollution poses the greatest threat to these turtles. The greatest cause of decline in green turtle populations is commercial harvest for eggs and food in nesting areas outside the U.S. Incidental catch during commercial shrimp trawling is a continuing source of mortality that adversely affects recovery in North America (NOAA 2001). Today, TEDs pulled by shrimp boats help reduce mortality from net entanglement.

2.3.10.11 Kemp's Ridley Sea Turtle

The Kemp's Ridley sea turtle (L. kempii) was listed as endangered throughout its range (Gulf of Mexico and Atlantic Ocean) on December 2, 1970, and its status has remained unchanged (Figure 2.3.10.11-1). The Kemp's Ridley population has declined since 1947 (when an estimated 42,000 females nested in one day) to a nesting female population of about 300 in the mid-1980s (Crowder and Heppell, 2011). The decline of this species was primarily due to human activities including collection of eggs, fishing for juveniles and adults, killing adults for meat and other products, and direct take for indigenous use. In addition to these sources of mortality, Kemp's Ridley sea turtles have been subject to high levels of incidental take by shrimp trawlers (Crowder and Heppell, 2011). Today, under strict protection, the population appears to be in the earliest stages of recovery. The increase can be attributed to two primary factors: full protection of nesting females and their nests in Mexico, and the requirement to use TEDs in shrimp trawls both in the U.S. and Mexico (NOAA 2001). Despite this population recovery, abnormally high numbers of immature Kemp's Ridleys stranded dead from 2010-2012 in the north central Gulf of Mexico, with the highest quantity occurring in Mississippi (Sea Turtle Stranding and Salvage Network). Additionally, immature Kemp's Ridleys have been incidentally captured by recreational fishermen at Mississippi fishing piers. In 2012, almost 200 Kemp's Ridleys were captured and rehabilitated. These numbers indicate that the Mississippi Sound is an important developmental habitat for Kemp's Ridleys, which has been previously suggested (Ogren, 1989). Kemp's Ridley sea turtle is considered the most endangered of all sea turtles because

there is only one known major nesting area, which is along the Mexican portion of the Gulf coast. They prefer shallow coastal and estuarine waters, usually over sand or mud bottoms. Most adults are restricted to the Gulf of Mexico, while the juveniles usually inhabit the Gulf and Atlantic Coasts.

2.3.10.12 Alabama Red-bellied Turtle

Figure 2.3.10.12-1.
Alabama Red-Bellied Turtle

The Alabama red-bellied turtle (*P. alabamensis*) is a relatively large freshwater turtle with a carapace (top shell) length of up to 13 inches (Figure 2.3.10.12-1). The plastron (bottom shell) is orange to red in color; the carapace is olive green, brown, or black, accompanied by distinct vertical markings in yellow, orange or red. The Alabama red-bellied turtle is distinguished from other similar species by the stripes of color on its head, and also the shape of the upper jaw (USFWS 1989). This turtle primarily feeds on aquatic plants and is most common in sluggish bays and bayous in brackish marshes adjacent to the main channels of large coastal rivers. In Alabama, the turtle is known from the lower reaches of the Alabama River and its tributaries in Baldwin and Mobile Counties. In Mississippi, recent surveys have located Alabama red-bellied turtles in the lower reaches of the Old Ft. Bayou, Escatawpa, and Pascagoula Rivers in Jackson County, and Tchoutacabouffa and Biloxi Rivers in Harrison County.

This turtle was listed as endangered by the USFWS on June 16, 1987; it is threatened by low reproductive success and taking of adult turtles. Although adult turtles spend most of their time feeding and basking in SAV, they must return to land to lay eggs. Disturbance of nests and destruction of eggs have been identified as major threats to the population; local residents collect eggs and live turtles for food. Recreational use of natural sand beaches have also disturbed nests and dredged material areas, such as Gravine Island in Alabama (USFWS 1989). Feral pigs, crows, and fire ants also raid nests to eat turtle eggs. Some collection of these turtles for the pet trade still persists, as does trawling to collect turtles for food. Some turtles are harvested accidentally by commercial fishermen in nets, traps, and trawls. Recovery efforts include learning more about the life history of the species; protecting nests in recreational areas; preventing destruction of aquatic vegetation used for basking, cover, and food; preventing taking of eggs and adult turtles through law enforcement; and educating the public about turtle conservation.

The Alabama red-bellied turtle is found in the lower Pascagoula River and its tributaries: Bluff Creek and the Escatawpa River. This species is abundant in quiet backwater areas with dense submerged vegetation, in water generally 3.3 to 6.6 feet deep (McCoy and Vogt, 1985). This species uses dense beds of aquatic vegetation for basking and is known to nest in sandy areas along natural riverbank levees.

2.3.10.13 Yellow-Blotched Map Turtle

The yellow-blotched map turtle (*G. flavimaculata*) is a small turtle getting its name from the distinctive yellow blotches on its carapace (top shell) (Figure 2.3.10.13-1). The turtle has a greenish-black body covered with yellow stripes. The plastron (bottom shell) is yellow to tan in color. Adult male turtles have been observed with carapace length between 3.5 to 4.8 inches, while the normally larger female turtles have been observed with carapace length of 4.1 to 8.5 inches (USFWS 1993). Several prominent spine-like projections extend from the top of the carapace. Yellow-blotched map turtles are endemic to the Pascagoula River system. They live in the main channels of rivers and large creeks; they have also been observed in oxbow lakes (USFWS 1993). These turtles have been observed in the Pascagoula and Escatawpa Rivers in Jackson County. Yellow-blotched map turtles avoid small streams where the surface of the water is shaded by bank vegetation. Aquatic insects and snails are thought to make up a large part of the turtles' diet. Turtles often bask on snags and logs fallen in the water. Nesting occurs during the summer months on sandbar beaches.

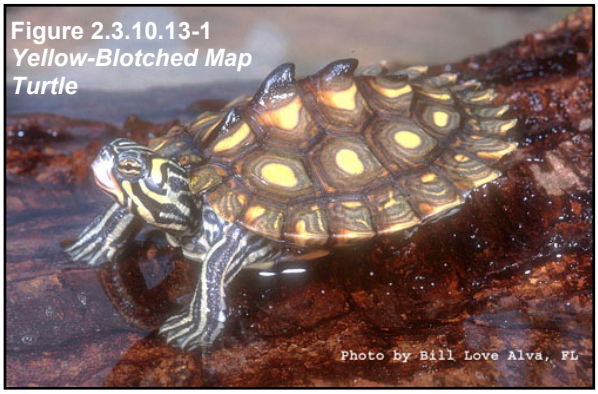


Figure 2.3.10.13-1
Yellow-Blotched Map Turtle

Yellow-blotched map turtle populations in the upper Pascagoula watershed have been in decline since the early 1990s. Navigation improvement projects to remove logs and snags from the Pascagoula River have taken away structures needed by the turtles for basking (USFWS 1993). Snag removal has also adversely impacted populations of the turtles' invertebrate prey that use snags as habitat. Gravel mining activities in the watershed have increased sedimentation and further impacted aquatic invertebrate populations. Four reservoirs and ongoing channel modification projects in the Pascagoula River system have altered or eliminated sandbars that turtles use for nesting. These small, colorful turtles are illegally collected for the pet trade, and basking turtles are used for target practice by some individuals (USFWS 1993). Some turtles have been observed to drown in illegal catfish traps.

Water pollution is a serious problem in some Pascagoula River tributaries. Permitted industrial and municipal effluents degrade water quality (USFWS 1993). Brine discharge from oil fields and a dioxin spill in the Pascagoula River have also impacted river water quality. Sedimentation and water pollution are threats to aquatic invertebrates, a main food source for the turtles. Food availability is thought to be a limiting factor for turtle populations. Reproduction might be impaired by lack of nesting habitat, exclusion of the turtles from suitable nesting beaches by excessive human presence, or effects of chemical pollutants on turtle reproductive biology. Direct and indirect adverse impacts to yellow-blotched map turtles would be expected from point and non-point source discharges of toxic chemicals, brine, sewage, and sediment to the Pascagoula River system (USFWS 1993).

2.3.10.14 Black Pine Snake

The black pine snake (*P. melanoleucus lodingi*) is one of 15 subspecies of a widespread snake species commonly called bullsnake or gopher snake (Figure 2.3.10.14-1). This non-venomous snake with black or dark brown scales and a reddish or white snout can grow up to 8.3 feet in length (Jordan 1998). Black pine snakes feed on small mammals, but will also take other vertebrates, such as birds, lizards and other snakes. The black pine snake was once known in longleaf pine forests from extreme southeastern Louisiana, east to southern Mississippi, to extreme southwestern Alabama (Jordan 1998). Recent surveys have found the highest concentration of black pine snakes in DeSoto National Forest in Mississippi, including habitat in Harrison County (USFWS 2001b). The snakes are known from eight other Mississippi counties and three counties in Alabama. Black pine snake is believed to

be extirpated from Louisiana (Natureserve 2001a), and has been listed as a candidate for protection under the ESA.

Source: USFWS

Figure 2.3.10.14-1
Black Pine Snake

Black pine snakes require well-drained, upland longleaf pine forest with few shrubs and abundant herbaceous vegetation. Historically, these conditions were maintained with frequent wildfires. Longleaf pine forests were once abundant in the southeastern U.S., but have been reduced to less than 5 percent of their former range (USFWS 2001b). Degradation, fragmentation, and fire suppression of upland longleaf forests is thought to be responsible for the decline of black pine snakes (Natureserve 2001a). Conversion of upland habitats to urban development, agriculture, and pine plantation have made habitat unsuitable for the species. Pine snakes avoid forests with a dense mid-story shrub layer, which is often the result of fire suppression (USFWS 2001b). There is evidence that the snakes use the underground portions of rotting pine stumps for shelter. Modern forestry practices that remove stumps and downed trees before replanting threaten the survival of black pine snakes (Natureserve 2001a). Direct human impacts such as roadkill, shooting, and collecting black pine snakes for the pet trade are thought to be significant threats to the snake's survival (USFWS 2001b).

2.3.10.15 Gopher Tortoise

The gopher tortoise (*G. polyphemus*) is a terrestrial turtle with a carapace (top shell) length between 12 to 24 inches (USFWS 1990a). The carapace is dark brown to gray-black, and often worn smooth from moving through the deep burrows it digs for shelter (Figure 2.3.10.16-1). The gopher tortoise is found in the southeastern coastal plain from Louisiana to South Carolina, although it is rare and scattered throughout its range. Gopher tortoises can live for several decades. Depending on habitat quality, it may take between 10 and 20 years for tortoises to become sexually mature. Egg laying and nesting takes place in the spring months. Clutch size is usually between 5 and 9 eggs. Nest predation is high, with roughly 90 percent of gopher tortoise nests destroyed by predators, such as raccoons, armadillos, and opossums. Predation on hatchling tortoises is also very high. Research indicates that hatchling mortality rates of more than 90 percent are not unusual (Natureserve 2001c).

Source: USFWS

Figure 2.3.10.15-1
Gopher Tortoise

Gopher tortoises are found in a variety of upland habitats. The best tortoise habitat consists of open upland woodlands with well-drained sandy soils suitable for easy burrowing. An open tree canopy lets in sunlight necessary for the growth of grasses and herbaceous plants on which the gopher tortoise feeds (USFWS 1990a). Sunlight is thought to be necessary for tortoise basking thermoregulation, and also for egg incubation while nesting (Natureserve 2001c). Periodic low-intensity fires have been observed to be beneficial to maintaining gopher tortoise habitat. In the western part of its range, including Mississippi, gopher tortoises inhabit xeric longleaf pine–scrub oak forests located on sand ridges. They may also found on the edges of crop fields, in pastures, and power line right-of-ways (USFWS 1990a).

The gopher tortoise has been listed threatened by the USFWS. The species population has undergone an 80 percent decline in the past 100 years (Natureserve 2001c). Decline is expected to continue because of habitat elimination and fragmentation. In the early 20th Century, gopher tortoises were collected for food. This problem has decreased, although tortoises continue to be adversely impacted by rattlesnake collectors who pour toxic substances down gopher tortoise burrows in order to flush out resident rattlesnakes. Road kill is also a persistent problem for adult turtles. The most frequently cited reason for gopher tortoise decline throughout its range is loss of habitat. Conversion of pinelands to agricultural lands has reduced gopher tortoise habitat in Mississippi. Fire suppression in longleaf pine natural communities has resulted in an increase in shrub cover and a decrease in herbs and grasses used for food. Throughout its range, conversion of open woodlands to dense slash pine plantation monocultures has eliminated large tracts of suitable habitat. In Florida, urbanization has also eliminated gopher tortoises and tortoise habitat.

2.3.10.16 Mississippi Gopher Frog

The Mississippi gopher frog (*R. capito sevosa*) is a medium-sized, stocky frog with brown, black, or gray coloration and many dark spots and warts (Figure 2.3.10.17-1). Adult frogs reach approximately 3 inches in body length. These frogs spend considerable time underground in abandoned gopher tortoise burrows, mammal burrows, and under tree stumps (USFWS 2000). Mississippi gopher frogs breed in isolated ponds surrounded by sandy, upland, longleaf pine forest. Breeding ponds only fill with water after substantial winter rains; Mississippi gopher frogs, therefore, do not reproduce successfully in drought years. The Mississippi gopher frog population has been reduced to approximately 100 known individuals near one breeding pond in Harrison County, Mississippi. Development projects in the vicinity of the pond have severed movement corridors that formerly helped sustain the frog population and otherwise have deteriorated remaining frog habitat. The species was at one time known from coastal counties and parishes from the Mississippi River in Louisiana east to the Mobile River in Alabama (USFWS 2000).

Source: USFWS

Figure 2.3.10.16-1
Mississippi Gopher Frog

The Mississippi gopher frog was listed as endangered whenever found west of the Mobile and Tombigbee Rivers in Alabama, Mississippi, and Louisiana (USFWS 2001). Threats to the last remaining frog population include inbreeding, local changes in hydrology, fire suppression, sedimentation, toxic chemical runoff, and habitat destruction and fragmentation. The last remaining breeding pond used by the species is located within 656 feet of a proposed highway, housing development, and golf course (USFWS 2000).

2.3.10.17 Gulf Sturgeon

The Gulf sturgeon (*A. oxyrhynchus desotoi*) was listed throughout its range as a threatened subspecies on September 30, 1991. The Gulf sturgeon, considered a subspecies of the Atlantic sturgeon *(A. oxyrhynchus)*, is an anadromous fish, migrating from saltwater into large coastal rivers (Figure 2.3.10.17-1). Historically, the Gulf sturgeon occurred in rivers from the Mississippi River to the Suwannee River, and in bays and estuaries from Florida to Louisiana. Little is known about current population levels outside the Suwannee, Apalachicola and Pearl Rivers, but they are thought to have declined from historic levels.

Source: USFWS

Figure 2.3.10.17-1
Gulf Sturgeon

Adult fish spend 8 to 9 months each year in rivers and 3 to 4 of the coolest months in estuarine Gulf rivers. In the Suwannee River, adult sturgeons frequent areas near the mouths of springs and cool water rivers during the summer months. Adult fish tend to congregate in deeper waters of rivers with moderate currents and sandy and rocky bottoms. Seagrass beds with mud and sand substrates appear to be important marine habitats. The adult Gulf sturgeon is known to spend the fall and winter months in the estuary of Mississippi Sound and migration routes extend from the Sound to the Back Bay of Biloxi. Occurrences of the Gulf sturgeon have been documented within Mississippi Sound, Biloxi River, and Pascagoula River area. The Gulf sturgeon is known to spawn in the Pearl River system. Major threats to this rare, primitive species include physical barriers (e.g., locks and dams) to spawning grounds, habitat loss, and poor water quality.

On March 19, 2003, USFWS and NOAA designated 14 geographic areas among the Gulf of Mexico rivers and tributaries as critical habitat for the Gulf sturgeon (Fed. Reg. Vol. 68, No. 53). These 14 geographic areas encompass approximately 1,739 river miles and 2,333 square miles of estuarine and marine habitat. In Mississippi, the critical habitat includes 243 miles of the Pearl River, including Bogue Chitto, and 126 miles of the Pascagoula River, including the Leaf, Bouie, Chickasawhay, and Big Black Creek tributaries.

The Gulf sturgeon is a federally listed threatened species that may occur within the project study area. The Gulf sturgeon inhabits marine environments, with adults entering rivers in the spring for spawning and moving back out to sea in the fall. Upon reaching sexual maturation (10 to 12 years locally for females and 7 to 9 years locally for males), Gulf sturgeon migrate into freshwater rivers (spawning areas) from mid-February through May to spawn (Ross, 2001; Boschung and Mayden, 2004; NatureServe, 2007). Their present range extends from Lake Pontchartrain and the Pearl River areas of Louisiana and Mississippi into Florida near the Suwannee River (NatureServe, 2007). The majority of spawning movement occurs at water temperatures of 60.8 to 77 degrees F and does not seem to be tied to river discharge (Ross, 2001). Spawning habitats preferred by Gulf sturgeon in Mississippi are riffle areas over hard bottoms, such as gravel or cobble. Females typically lay around 400,000 eggs (about 25 percent of body weight), which adhere to the rocky substrate (Ross, 2001; USFWS, 2003; Boschung and Mayden, 2004). After spawning, adults typically remain in the spawning area or move downstream to summer resting areas before ultimately returning to the Gulf in October and November.

One-hundred-forty-five Gulf sturgeon were captured, tagged, and released from the Pascagoula River. The results of the study indicated that the fish congregated in holding areas in the lower portion of the River from May to November and migrated out of these areas and back into the Gulf of Mexico from late-September to mid-October (Heise et al., 2005). These offshore fall migrations were prompted by

shorter day lengths, falling seasonal water temperatures, and elevated river discharge (Heise et al., 2005). In addition, tissue analyses have indicated that the Gulf sturgeon exhibits strong natal river fidelity (USFWS, 2003).

Juvenile Gulf sturgeon may spend as little as 1 year to as many as 6 years in the nursery areas of freshwater habitats before migrating into estuarine and marine waters (Ross, 2001). Migration downstream begins in September and occurs through November, coinciding with higher pulses in river discharges (USFWS, 2003). Adult and sub-adult sturgeon typically spend cooler months (October through April) in nearshore estuaries. The habitat preferred by Gulf sturgeon in the Mississippi Sound barrier islands has a sandy substrate and an average depth of 6.2 to 19.3 feet (Ross, 2001; USFWS, 2003). Gulf sturgeon feed by rooting with their sharp snouts along the bottom and sucking prey into the protrusile mouth (Ross, 2001). Typically, marine and estuarine prey have soft bodies and include lancelets, polychaete worms, gastropods, shrimp, amphipods, and isopods (Ross, 2001; USFWS, 2003; Boschung and Mayden, 2004; Huff, 1975). Freshwater prey include benthic macroinvertebrates (i.e. aquatic insects and oligochaetes) and bivalve mollusks (Ross, 2001).

The benthic macro-invertebrate community was surveyed around SRI, the West Pascagoula River, and Bayou Casotte in 2005 to evaluate potential food sources for the sturgeon. Data collected from 12 stations were compared to results from a similar 1980 survey of those locations. Results suggest that changes in sediment composition to sandier substrates led to a change in dominant taxa between 1980 and 2005. A decrease in both taxa richness and density was also observed at each of those stations. Diverse assemblages of polychaetes, mollusks, and amphipods have shifted to communities dominated by opportunistic polychaete taxa. The study concluded that the changes in community structure were indicative of the dynamic nature of benthic communities in shallow coastal areas of the Gulf of Mexico. The assemblages in the SRI area and in the Mississippi Sound reflect the influences of annual variation in riverine inputs and numerous hurricanes which have impacted the northern Gulf in the past 25 years (USACE, 2005).

During the annual life history migrations, the Gulf sturgeon's distribution overlaps the area of the Federal Pascagoula Harbor Navigation Channel (USFWS, 2003). The Gulf sturgeon was listed as federally threatened in 1991, but the USFWS did not designate critical habitat for this species until March 2003 (USFWS, 1991; USFWS 2003). Unit 2 of the designated critical habitat for the Gulf sturgeon includes the Pascagoula River and Unit 8 encompasses 62 square miles of the Mississippi Sound nearshore area (Figures 2.3.10.17-2 and 2.3.10.17-3) (USFWS, 2011).

Unit 2 includes all of the Pascagoula River main stem and its distributaries, portions of the Bouie, Leaf, and Chickasawhay tributaries, and all of the Big Black Creek tributary. The main stem of the Chickasawhay River from the mouth of Oaky Creek, Clarke County, Mississippi, downstream to its confluence with the Leaf River, George County, Mississippi to the discharge of the East and West Pascagoula Rivers into Pascagoula Bay, Jackson County, Mississippi, is included. All of the main stem of the Pascagoula River from its confluence with the Leaf and Chickasawhay Rivers, George County, Mississippi, to the discharge of the East and West Pascagoula Rivers into Pascagoula Bay, Jackson County, Mississippi is included. The lateral extent of Unit 2 is the ordinary high water line on each bank of the associated rivers and shorelines. Subpopulation estimates, calculated from sturgeon captures in 1999 and 2000 in the summer holding areas on the Pascagoula River, range between 162 and 216 individuals (Heise *et al.*, 1999a; and Ross *et al.*, 2001b). Due to the sampling technique, these estimates are based primarily on large fish and do not account for juvenile or subadult fish.

Gulf sturgeon spawning on the Bouie River was confirmed via egg collection in 1999 (Slack *et al.*, 1999; and Heise *et al.*, 1999a). This is the only confirmed spawning area in the Pascagoula River drainage. Downstream, the Bouie River is sometimes used as a summer holding area (Ross *et al.*, 2001b). Gulf sturgeon have been documented using the area above the known spawning habitat approximately 0.50 river mi north of Glendale Road. Additional use has included all distributaries on

the Escambia River system (*i.e.*, White River, Little White River, Simpson River, and Dead River) in Unit 3.

In Unit 2, Gulf sturgeon use the West and East distributaries of the Pascagoula River during spring and fall migrations (Ross *et al.*, 2001b). Summer resting areas have been consistently documented on the Pascagoula River (Ross *et al.*, 2001a and b). The Pascagoula River Harbor is on the East Pascagoula River distributary, a small portion of this overall unit, but used for migration and/or summer resting areas and probable feeding use by juveniles. All of the Federal navigation channels in Pascagoula Harbor are excluded from designation.

Unit 8 encompasses Lake Pontchartrain east of the Lake Pontchartrain Causeway, all of Little Lake, The Rigolets, Lake St. Catherine, Lake Borgne, including Heron Bay, and the Mississippi Sound. Mississippi Sound includes adjacent open bays including Pascagoula Bay, Point aux Chenes Bay, Grand Bay, Sandy Bay, and barrier island passes, including Ship Island Pass, Dog Keys Pass, Horn Island Pass, and Petit Bois Pass. The northern boundary of the Mississippi Sound is the shoreline of the mainland between Heron Bay Point, Mississippi and Point aux Pins, Alabama. The southern boundary follows along the broken shoreline of Lake Borgne created by low swamp islands from Malheureux Point to Isle au Pitre. From the northeast point of Isle au Pitre, the boundary continues in a straight north-northeast line to the point 1 nm seaward of the western most extremity of Cat Island. The southern boundary continues 1 nm offshore of the barrier islands and offshore of the 72 COLREGS (International Regulations for Preventing Collisions at Sea of 1972) lines at barrier island passes to the eastern boundary. Between Cat Island and Ship Island there is no 72 COLREGS line. The USFWS and NMFS, therefore, have defined that section of the unit southern boundary as 1 nm offshore of a straight line drawn from the southern tip of Cat Island to the western tip of Ship Island. The eastern boundary is the line of longitude 88°18.8'W from its intersection with the shore (Point aux Pins) to its intersection with the southern boundary. The lateral extent of Unit 8 is the mean high water (MHW) line on each shoreline of the included waterbodies or the entrance to rivers, bayous, and creeks.

The Pascagoula River and its distributaries flow into Pascagoula Bay and Mississippi Sound. This unit provides juvenile, subadult and adult feeding, resting, and passage habitat for Gulf sturgeon from the Pascagoula and the Pearl River subpopulations. 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, Mississippi Sound, within 1 nm of the nearshore Gulf of Mexico adjacent to the barrier islands and within the passes (Davis *et al.*, 1970; Reynolds, 1993; Rogillio, 1993; Rogillio *et al.*, 2002; and F. Parauka). Substrate in these areas range from sand to silt, all of which contain known Gulf sturgeon prey items (Menzel, 1971; Abele and Kim, 1986; and American Fisheries Society, 1989). Mississippi Sound is separated from the Gulf of Mexico by a chain of barrier islands, including Cat, Ship, Horn, and Petit Bois Islands. Natural depths of between 12 to 18 feet are found throughout the Sound. Incidental captures and recent studies confirm that both Pearl River and Pascagoula River adult Gulf sturgeon winter in the Mississippi Sound, particularly around barrier islands and barrier islands passes (Reynolds, 1993; Ross *et al.*, 2001a; and Rogillio *et al.*, 2002). Pascagoula Bay is adjacent to the Mississippi Sound. 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, Louisiana (Ross *et al.*, 2001a). 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 (Rogillio *et al.*, 2002). Gulf sturgeon have also been documented within 1 nm off the barrier islands of Mississippi Sound; therefore, the NMFS and USFWS have included 1 nm offshore of the barrier islands of Mississippi Sound. Habitat used by Gulf sturgeon in the vicinity of the barrier islands is 6.2 to 19.4 feet deep (average 13.8 feet), with clean sand substrata (Heise *et al.*, 1999b; Ross *et al.*, 2001a; and Rogillio *et al.*, 2002). Preliminary data from substrate samples taken in the barrier island areas indicate that all samples contained lancelets (Ross *et*

*al.*2001a). Inshore locations where Gulf sturgeon were located (Deer Island, Round Island) were 6.2 to 9.2 feet deep and all had mud (mostly silt and clay) substrata (Heise *et al.*, 1999b), typical of substrates supporting known Gulf sturgeon prey.

The PCEs essential for the conservation of the Gulf sturgeon are those habitat components that support foraging, riverine spawning sites, normal flow regime, water quality, sediment quality, and safe unobstructed migratory pathways. The proposed project area is found within Units 2 and 8 of the Gulf sturgeon critical habitat. Bayou Casotte and Mississippi Sound system provides feeding, water quality, sediment quality, and migration habitat for Gulf sturgeon.

Little data is available on Gulf sturgeon feeding habits. Their threatened status limits sampling efforts. Generally, adults and subadults could be described as opportunistic benthivores typically feeding on benthic marine invertebrates including amphiopods, lancelets, polychaetes, gastropods, shrimp, isopods, mollusks, and crustaceans. The benthic community noted by Vittor and Associates (1982) within Mississippi Sound provides suitable forage habitat for adult and subadult fish. It is highly likely that the benthic assemblages within the project area would provide suitable forage for Gulf sturgeon.

As Gulf sturgeon feed principally on benthic invertebrates, potential impacts to the “winter-feeding” constituent element would be confined to possible impacts to the benthic community. Vittor and Associates (1982) classified the benthic community in a study of Mississippi Sound and selected sites in the Gulf of Mexico. In the Sound, a total of 437 taxa were collected at densities ranging from 1,097 to 35,537 individuals per square meter. Generally, densities increase from fall through the spring months since most of the dominant species exhibit a late winter to early spring peak in production. Species diversity, evenness, and species richness (number of taxa) demonstrate only minor inconsistent temporal fluctuations. Biomass per unit area also increases from fall to spring, primarily as a result of higher densities. Vittor and Associates (1982) named several opportunistic species that are ubiquitous in Mississippi Sound and nearshore Gulf of Mexico. These species, though sometimes low to moderate in abundance, occur in a wide range of environmental conditions. They are usually the most successful at early colonization and thus tend to strongly dominate the sediment subsequent to disturbances, such as dredging activities. These species include: *Mediomastus spp*., *Paraprionospio pinnata, Myriochele oculata, Owenia fusiformis, Lumbrineris app., Sigambra tentaculata*, the *Linopherus-Paraphinome* complex, and *Magelona cf. phyllisae*. The phoronid, *Phoronis* sp., and the cumacean, *Oxyurostylis smithi*, also fit this category. *M. oculata* and *O. fusiformis* are predominate species in Mississippi Sound. The project site lies within the area categorized by Vittor as the shallow coastal margin mud habitat. The numerically dominant species collected during the study, *Mediomastus californiensis* and *Paraprionospio pinnata*, dominated the samples collected by Vittor and Associates, Inc. (1982).

Macroinfauna are good indicators of the health of an estuarine system and are useful in determining changes since the factors affecting their distribution are well-known (Collard and D’Asaro, 1973). Substrate type is paramount in determining the composition of the benthic community of a given area. Salinity fluctuation and range, wave shock and tidal exposure follow in importance. The structure of a community and how it changes through time are important determinants in assessing impacts from various stresses. As mentioned earlier, the successional stage of the macroinfauna can range from azoic, pioneering, intermediate, to climax communities (Rhoads and Germano 1986). Pioneering communities are dominated by smaller organisms with little ability to burrow more than a few millimeters into the substrate. The taxa are typically dominated by deposit feeding organisms with sucking types of feeding apparatus. Climax communities are dominated by larger invertebrates adapted to deep burrowing activities. The taxa contain many larger “top-down” feeders and a large variety of predatory type organisms. Shallow areas, which are controlled by physical events, such as storms and waves, are typically populated only by pioneering communities whereas deep areas in which physical disturbance is not a controlling factor are typically populated by intermediate and climax communities. Diversity, which is a measure of the distribution of individual organisms among the

various species, is another tool in assessing the health of a community. Low diversity is typically a good indicator of stress, either natural or manmade, while high diversity is generally indicative of stable communities rich in taxa with relatively few dominant species. For example, a Stage I or pioneering community would be characterized by low diversity, i.e. expect to find lower numbers of taxa with high dominance of a few of the taxa. On the other hand, a Stage III or climax community would be relatively high in diversity, containing variable numbers of taxa but with a tendency towards equal distribution of individuals among the taxa.

Diversity, however, is not a good descriptor of the value of the community as a resource, i.e. food source for higher trophic individuals. For example, the Stage I, low diversity, community, is an excellent resource because of the tremendous numbers of individuals and high turnover rate. Therefore to determine the overall health and value of a community, all community descriptors must be used in determining the significance of any impacts to the benthic community.

The “water quality” PCE is of concern to Gulf sturgeon critical habitat. Temperature, salinity, pH, hardness, turbidity, oxygen concentrations, and other chemical characteristics must be protected in order to preserve normal behavior, growth, and viability of all Gulf sturgeon life stages. If water quality is severely degraded, adverse impacts to Gulf sturgeon and its critical habitat may result. Water quality in Mississippi Sound has historically been more turbid than that of the Gulf of Mexico due to various influences, such as the river emptying into the Sound, wave and wind energy, and commercial fishing activities. The species continues to utilize the area despite these turbid conditions.

The “sediment quality” PCE is listed to ensure sediment suitability (i.e. texture and other chemical characteristics) for normal behavior, growth, and viability of all life stages. In addition, sediment quality is of a concern to support a viable benthic community in order to allow the Gulf sturgeon continual foraging of the area. Sediment collected from the USACE, Mobile District’s 2010 sampling effort of the Bayou Casotte Channel (i.e. from the mouth southward to the “Y” injunction) consisted of a mixture of sands, silts, and clays. The sandy material was found more at the northern end and reduced approaching the “Y” injunction. Silts and clays were found throughout the channel. In the Lower Pascagoula Channel, sediment consisted of mixture of sands, silts, and clays. Gulf sturgeon(s) are likely to feed upon the benthic community within the silty and sandy sediment found in the Mississippi Sound area and near the barrier island system.

The “migration habitat” PCE is concerned with ensuring safe unobstructed passage for the species. It is intended primarily for the more confined areas near the river mouths or the rivers themselves. The species could potentially migrate through the project area.

Mississippi Sound is separated from the Gulf of Mexico by a chain of barrier islands. Several incidental captures and recent studies have confirmed extant populations of the Gulf sturgeon wintering in this area, particularly around the barrier islands and passes. The USFWS has reported several collections of Gulf sturgeon in the immediate vicinity of the Pascagoula Harbor Navigation Channel, including specimens in the embayment of the western fork of the Pascagoula River and along the lower 3 miles of the Pascagoula River proper (USFWS, 1995). When designating critical habitat for the Gulf sturgeon, the USFWS excluded those areas in the vicinity of the major shipping channels (USFWS, 2003).

Figure 2.3.10.17-2
Gulf Sturgeon Critical Habitat- Project Area

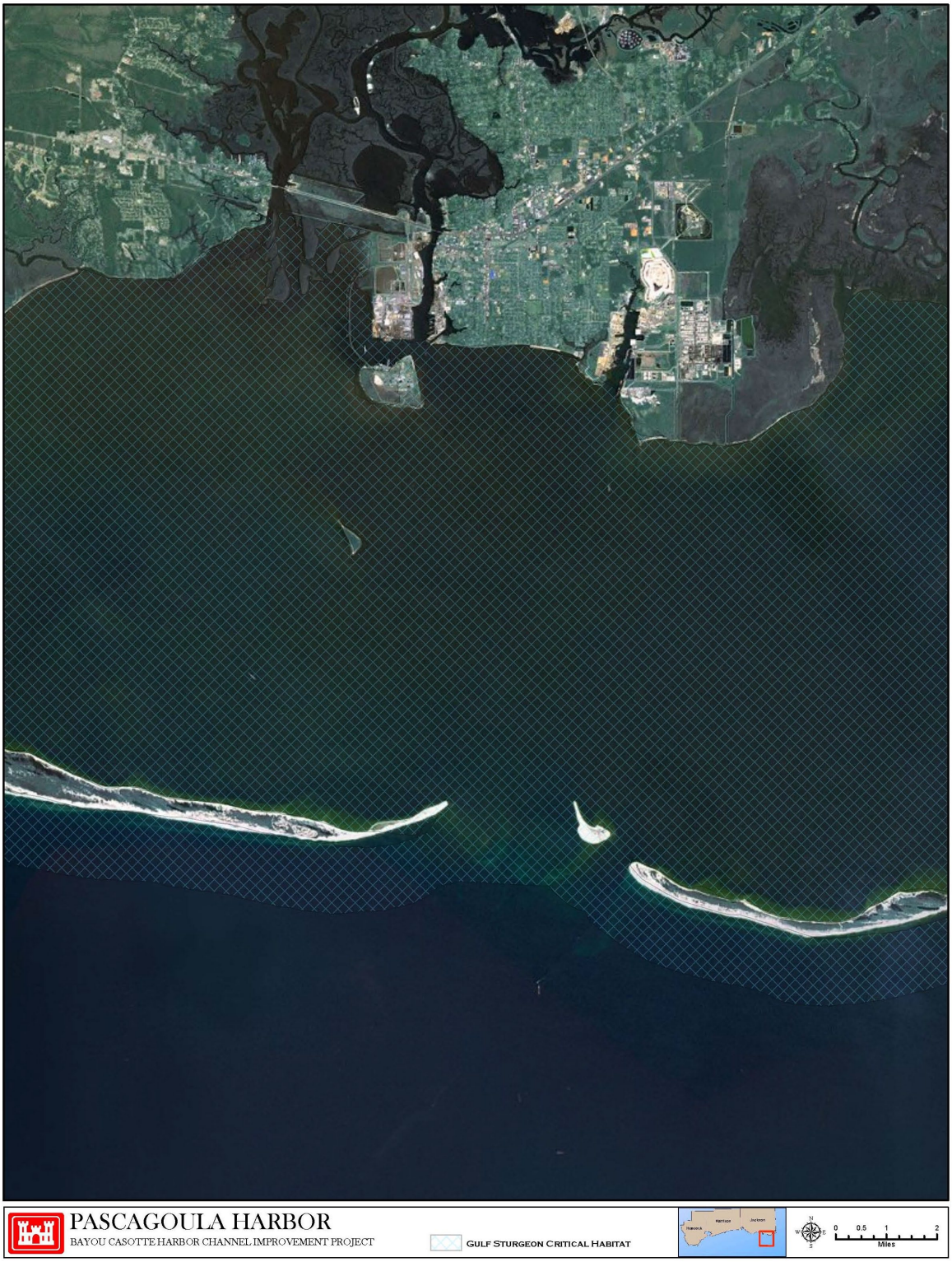


Figure 2.3.10.17-3
Gulf Sturgeon Critical Habitat- Unit(s) 1, 2, and 8

2.3.10.18 Pearl Darter

The pearl darter (*P. aurora*) is a small fish in the perch family that usually grows to just over 2 inches in length. It has a blunt nose, horizontal mouth, large eyes placed high on the head, and a black spot on the caudal fin (Figure 2.3.10.18-1). Pearl darters have been collected in rivers and large creeks with moderate current and sand and gravel substrates. It is not found in deep, sluggish pools, lacustrine environments, or headwater creeks with insufficient flow. Chironomids and small crustaceans probably make up a large part of pearl darter diet (USFWS 2001e).

Never considered abundant, the pearl darter was once found in both the Pearl and Pascagoula River systems. It has not been collected in the Pearl River system since 1973. The pearl darter is thought to be restricted to 88 river miles of the Pascagoula River watershed (USFWS 2001e). The pearl darter has the potential to occur in the Pascagoula River and its tributaries in Jackson County. Threats include sedimentation from forestry and development in the watershed, permitted industrial and municipal discharges of toxic chemicals and sewage, sand and gravel mining, and proposed impoundments for reservoirs. Sand and gravel mining activities are ongoing in the Pascagoula River system. In-stream mining not only removes substrates preferred by the pearl darter, it also delivers sediment to aquatic habitats downstream. Holes in river channels left by sand and gravel mining activities function similar to lake habitats, which pearl darters avoid (Natureserve 2001f).

Source: USFWS

Figure 2.3.10.18-1
Pearl Darter

2.4 Water Quality

The MDEQ monitors the water quality of surface water throughout the state. Water quality assessments are made from this information that give general characterizations of water body health. The state's most comprehensive assessment report is found in the Federal CWA Section 305(b) Water Quality Inventory Report.

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 driver of water quality is the rivers, including the Pascagoula River that feed into the Sound. Freshwater inputs 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 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 re-suspension of sediments. These suspended sediments give Mississippi Sound a characteristic brownish color (MDEQ, 2006b).

Dynamic features, such as the Loop Current, eddies, and river plumes, create variations in temperature, salinity, and water density. Temperature and salinity strongly influence chemical, biological, and ecological patterns and processes. Differences in water density affect vertical ocean currents and may also concentrate buoyant material, such as detritus and plankton. Greatest stratification in the water column occurs in summer (Thompson et al., 1999).

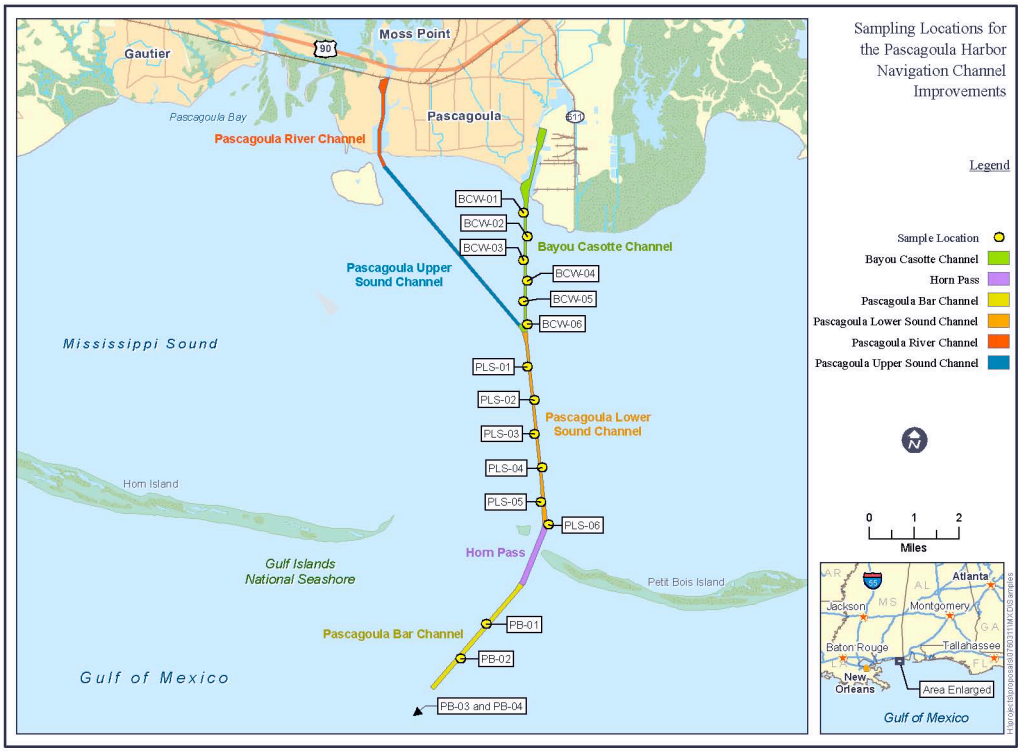
2.4.1 Salinity

Previous studies of the Mississippi-Alabama shelf found that bottom salinity was relatively constant year-round (36 ppt) and surface salinity ranged from 33 to 36 ppt. 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).

Within the navigation channel, the general trend is for increasing salinity with depth. This results from the combination of (1) denser water from outside the Sound moving along the channel toward shore and (2) less dense freshwater overrunning at the surface. In a 2005 sampling event, USACE study surface salinities measured in the Upper Pascagoula Channel ranged from 27 to 30 ppt. Bottom salinities ranged from 30 to 33 ppt. Salinity increased in the 4 stations in the Upper Pascagoula Channel from 3 to 6 ppt (USACE, 2006b).

In the 2010 USACE sediment and water quality analyses, salinity at the surface ranged from 17.4 to 26.2 ppt. Bottom salinities in Pascagoula Harbor are more complex because of the range of depths among the sites: 25 feet to 41 feet. Station PLS-01 (Figure 2.4.1-1) showed the greatest increase in salinity over depth, with a total increase of 8.4 ppt from the surface to the bottom (34 feet). Six stations in the project area had an increase of salinity between 3.5 and 5.5 ppt. Five stations had increases in salinity between 7.4 and 8.4 ppt or less from the top to the bottom of the water column.

Figure 2.4.1-1
Sampling Locations



2.4.2 Temperature

Thompson et al. (1999) identified the annual range in temperature for the Mississippi-Alabama shelf as 62.6 to 71.6°F. Temperatures in both deep and shallow water correspond to seasonal variations in air temperature, with higher temperatures in summer months and lower temperatures in cooler months

(Thompson et al., 1999). NCA data collected in the Sound by MDEQ from 2000 to 2005 indicated a range of temperatures in the Sound from 79.5 to 88.5 °F throughout the water column at all stations.

Data collected in spring of 2010 within the upper Pascagoula Channel showed a slight decrease in water temperature with depth. Surface temperatures ranged from 68.2 to 68.5°F (USACE, 2011).

Near the Pascagoula Harbor Navigation Channel (within 2 miles), temperature was fairly uniform, with little evidence of a strong thermocline and little temperature variation noted with depth. All stations displayed gradual decreases in temperature with no discontinuities indicative of a thermocline. Table 2.4.2-1 shows the temperature changes within the navigation channel.

Table 2.4.2-1
Mississippi Sound Water Temperature

LOCATION	WATER DEPTH (ft)	SAMPLE DEPTH	WATER TEMPERATURE (°C)	DISSOLVED OXYGEN (mg/L)	pH	TURBIDITY (NTU)	SALINITY (ppt)
BCW-01*	33	SURFACE	21.8	4.2	8.1	7.3	20.8
		MIDDLE	21.5	4.0	8.1	8.6	22.6
		BOTTOM	21.4	3.7	8.1	23.3	24.4
	34	SURFACE	22.4	4.1	8.0	7.2	18.5
		MIDDLE	21.6	3.7	8.0	22.0	22.5
		BOTTOM	21.5	3.7	8.1	30.9	23.8
BCW-02	38	SURFACE	22.9	4.4	8.1	5.4	17.4
		MIDDLE	21.7	4.2	8.0	10.5	22.1
		BOTTOM	21.6	4.0	8.0	13.9	22.9
BCW-03**	25	SURFACE	23.3	5.5	8.1	5.2	18.3
BCW-04*	41	SURFACE	21.7	4.5	8.2	9.9	21.5
		MIDDLE	21.9	4.4	8.2	6.9	33.9
		BOTTOM	20.3	2.8	8.1	5.5	29.0
	34	SURFACE	21.6	3.6	7.9	2.9	18.8
		MIDDLE	21.3	3.9	8.1	17.7	21.7
		BOTTOM	21.3	3.4	8.1	31.3	22.4
BCW-05	34	SURFACE	21.5	5.0	8.2	1.5	20.8
		MIDDLE	20.8	3.6	8.1	10.6	28.1
		BOTTOM	20.4	3.4	8.1	18.1	28.8

BCW-06	34	SURFACE	21.5	5.0	8.2	2.1	20.3
		MIDDLE	21.0	3.8	8.1	14.9	27.4
		BOTTOM	20.6	3.5	8.1	45.7	28.4
BCW-WAT	27	SURFACE	21.8	9.3	8.1	7.8	21.0
		5	20.8	5.6	8.0	6.6	27.5
		10	20.2	4.5	8.0	8.6	28.4
		15	20.1	4.4	8.0	9.6	28.9
		20	19.7	4.3	8.1	11.1	30.1
		25	19.5	4.2	8.1	18.3	30.7
		BOTTOM	19.4	4.1	8.1	18.6	31.0
PLS-01	34	SURFACE	21.1	4.7	8.2	2.0	19.9
		MIDDLE	21.0	3.4	8.1	15.9	27.4
		BOTTOM	20.7	2.9	8.1	27.4	28.3
PLS-02**	35	SURFACE	22.6	--	8.1	0.1	24.6
PLS-03**	35	SURFACE	21.5	--	8.1	1.5	25.9
PLS-04	35	SURFACE	21.4	5.5	8.3	0.6	22.0
		MIDDLE	20.5	4.9	8.3	2.3	28.7
		BOTTOM	20.3	4.6	8.2	5.5	29.4
PLS-05	28	SURFACE	21.1	5.3	8.3	0.6	24.3
		MIDDLE	20.1	4.7	8.2	6.6	29.6
		BOTTOM	20.1	4.5	8.2	7.2	29.6
PLS-06	36	SURFACE	20.8	5.2	8.3	0.3	26.2
		MIDDLE	20.9	5.3	8.3	0.4	26.5
		BOTTOM	20.3	4.8	8.3	3.3	29.2
PLS-WAT	27	SURFACE	21.5	8.6	8.2	4.5	21.7
		5	21.4	7.5	8.2	4.1	21.7
		10	20.4	5.9	8.2	3.3	28.1
		15	20.3	5.3	8.2	4.8	28.4
		20	19.8	4.4	8.1	6.5	29.9

		25	19.4	4.1	8.1	8.2	31.3
		BOTTOM	19.3	4.2	8.1	26.6	31.3
RS-PAS-B	51	SURFACE	20.61	8.2	8.4	0.1	25.2
		MIDDLE	20.64	7.2	8.4	0.5	25.3
		BOTTOM	17.28	1.5	7.8	0.8	31.5
RS-PAS-D	53	SURFACE	21.3	3.9	8.3	0	24.9
		MIDDLE	20.3	4.4	8.3	0	31.4
		BOTTOM	17.6	1.5	7.9	0.5	33.3

** YSI cable not long enough for middle or bottom water sampling at these locations
-- = instrument malfunction
*ft = feet, °C = Celsius, mg/L = milligrams per liter, NTU = Nephelometric Turbidity Unit

2.4.3 Dissolved Oxygen

Nearshore and open Gulf waters are normally at or near oxygen saturation. However, high organic loading, high bacterial activity related to decomposition of organic material, and restricted circulation due to stratification of the water column during summer, can cause near-bottom waters to be depleted of oxygen. Severe anoxic events are generally observed in waters west of the Mississippi Delta, but oxygen depletion problems do occur infrequently over the Mississippi inner shelf. Oxygen problems have also been reported on parts of the Alabama inner shelf (Thompson et al., 1999).

Dissolved oxygen conditions in Gulf Coast estuaries are generally good, except in a few highly eutrophic regions. USEPA estimates for Gulf of Mexico estuaries show that about 4 percent of the bottom waters have hypoxic conditions or low DO (<2 parts per million [ppm]) on a continuing basis in late summer. Near Pascagoula these areas are largely confined to small estuaries (USEPA, 2001). Table 2.4.2-1 shows the DO changes within the navigation channel.

2.4.4 Hypoxia

Conditions are said to be “hypoxic” when DO concentration is less than 2 mg/L. Such conditions occur annually during summer months in large portions of continental shelf waters. Hypoxic zones are created when the water column is sharply stratified by temperature and salinity, thus limiting exchange between bottom waters, surface waters, and the atmosphere. High concentrations of nutrients also influence DO concentrations in stratified waters. Elevated nitrogen concentrations promote algal and attendant zooplankton growth. The associated organic matter sinks to the bottom where it decomposes, consuming available oxygen (NOAA, 2004a).

An estimated 19 percent of the Sound is affected by hypoxia (USEPA, 1999). Hypoxia can cause fish to leave an area and can cause stress or death among bottom-dwelling organisms (NOAA, 2004a). Hypoxic conditions were not observed at the sampling stations sampled during the 2010 USACE sediment and water quality analyses in the Mississippi Sound, Upper Pascagoula Channel, or Bayou Casotte Channel.

2.5 Sediment Quality

The Pascagoula Harbor Lower Pascagoula & Bayou Casotte Channels dredged material evaluation collected data necessary to document the existing physical, chemical and ecotoxicological characteristics of the sediments (*Appendix D – Sediment Evaluation Report*). A total of 12 locations in the Pascagoula Harbor Navigation Channel (six locations in Bayou Casotte and six locations in Lower Pascagoula Channel) and two reference sites (Reference Site B and Reference Site D) were sampled for the testing program (Figure 2.4.1-1). Analytical results from the sampling effort facilitate the decision-making process to support placement of the dredged material. The project consisted of collecting sediments using a vibracore sampler at specified locations; collecting site water; conducting analytical testing of sediments, standard elutriates, site water, and ODMDS receiving water; conducting ecotoxicological testing; and evaluating test results.

2.5.1 Bulk Sediment Chemistry

The physical and chemical characteristics of six individual sediment samples from the Bayou Casotte Channel and three composite sediment samples from the Lower Pascagoula Channel (Figure 2.4.1-1) were determined to assess the sediment quality of the material proposed for dredging. Also, two reference sediment samples were collected from USACE/USEPA, Region 4 designated reference sites south of Horn Island, Mississippi (RS-PAS-B and RS-PAS-D). Concentrations of detected analytes in sediment samples from the Pascagoula Harbor Channels were compared to Sediment Quality Guidelines (SQGs) (MacDonald et al. 1996; MacDonald 1994; CCME 2001) for marine sediments to assess the sediment quality of the material proposed for dredging. SQGs were used to identify potential adverse biological effects associated with contaminated sediments.

The sediments from the Bayou Casotte Channel and the Lower Pascagoula Channel locations PLS-01 through PLS-04 were predominantly comprised of silt and clays. The silt+clay percentages of the Bayou Casotte samples ranged from 70.2 to 97.5 percent, the Lower Pascagoula Channel samples (PLS-01 through PLS-04) ranged from 65.5 to 92.2 percent silt+clay, and Reference Site B was 88.1 percent silt+clay. The sediments from the Lower Pascagoula Channel locations PLS-05 and PLS-06 were predominantly comprised of sand. The sand percentages of the Lower Pascagoula Channel location(s) PLS-06, PLS-06, and composite PLS-05/06 ranged from 85.1 to 91.3 percent sand and Reference Site D was 74.8 percent sand.

Each of the tested metals was detected in most of the sediments with the exception of mercury in the sediment from PLS-05/06 and from Reference Site D. Only one metal (arsenic) was detected at a concentration above the threshold effects limits (TEL). None of the detected metal concentrations in the sediment exceeded probable effects limits (PEL) concentrations. In general, concentrations of metals in the channel sediments were similar to their respective reference site (Reference Site B for Bayou Casotte Channel, PLS-01/02 and PLS-03/04, and Reference Site D for PLS-05/06). Additionally, the Simultaneously-Extracted Metals/Acid Volatile Sulfide (SEM/AVS) ratio was less than 1 for each of the nine sediment samples, indicating that the five simultaneously extracted metals included in the analysis (cadmium, copper, lead, nickel, and zinc) are not likely to be bio-available to aquatic organisms for the sediment samples from the Bayou Casotte Harbor Channel Improvement Project because the metals are bound by the sulfide binding ability of the sediment.

The organic constituents were infrequently detected and butyltins were not detected (ND) in any of the samples. None of the polycyclic aromatic hydrocarbons (PAHs) were detected at concentrations above the TEL values. Total PAH concentrations (ND=½ Method Detection Limit (MDL)) in the new work sediments ranged from 9.08 µg/kg to 57.4 µg/kg, and none were above the TEL values. Polychlorinated biphenyls (PCBs) in the channels were detected infrequently in the sediment and at low concentrations, often below the reporting limit. Total USEPA, Region 4 PCB concentrations

(ND=½MDL) in the channels were below the TEL value and the total USEPA, Region 4 PCB concentrations (ND=½MDL) at the reference sites were generally lower than the total PCB concentrations in the channels. Chlorinated pesticides were detected infrequently in the sediment and at low concentrations, often below the reporting limit. None of the chlorinated pesticides were detected between the TEL and the PEL values.

The dioxin and furan congeners were detected in the sediment samples from the channels in slightly more than half of the cases. The most toxic dioxin congener, 2,3,7,8-TCDD (-Tetrachlorodibenzo-p-dioxin), was detected in two of the nine samples at low concentrations. The dioxin total equivalent (TEQs) (ND=½RL (Reporting Limit)) from the channel sediments ranged from 0.662 parts per trillion (pg/g) to 30.1 pg/g, with the highest concentration reported for the sample from PLS-01/02 (Lower Pascagoula Sound). The dioxin TEQ (ND=½RL) from Reference Site B (5.46 pg/g) was within the range of the dioxin TEQs from Bayou Casotte Channel, PLS-01/02, and PLS-03/04. The dioxin TEQ (ND=½RL) from Reference Site D (1.08 pg/g) was lower than the dioxin TEQ from PLS-05/06. Semi-volatile organic compounds (SVOCs) in the channel sediments were detected infrequently and at low concentrations, often below the reporting limit. One of the detected concentrations of bis(2-ethylhexyl) phthalate was above the TEL value by a factor of 2.4. None of the SVOCs were detected at either of the reference sites. Butyltins were tested in the sediment samples from the channels. None of the butyltins were detected in any of the sediment samples from the channels or the reference sites.

2.5.2 Site Water and Standard Elutriate Testing

For the Bayou Casotte Harbor Channel Improvement Project, nine standard elutriates were prepared according to Inland Testing Manual guidelines (USACE/USEPA 1998) to evaluate open-water placement of the dredged material. The nine standard elutriates were created from the six individual samples from Bayou Casotte and the three composite sediment samples from the Lower Pascagoula Channel. Analytes detected in the elutriates were compared to USEPA saltwater acute and chronic water quality criteria. Criteria were derived from USEPA's *National Recommended Water Quality Criteria* (2010).

Site water chemistry results indicated several chemical constituents were detected in the site water sample from the Bayou Casotte Harbor Channel Improvement Project. Of the 163 tested constituents, 41 (25 percent) were detected, with metals being detected most frequently. None of the detected constituents were detected at concentrations above the USEPA saltwater acute or chronic water quality criteria. PAHs, PCBs, chlorinated pesticides, SVOCs, and dioxin and furan congeners were infrequently detected in the site water samples and no butyltins were detected.

In the standard elutriate samples, 50 of the 162 target analytes (31 percent) were detected. Generally, detected concentrations were low, but some constituents had concentrations that exceeded USEPA saltwater chronic and/or acute water quality criteria. Ammonia, cyanide, sulfide, copper, nickel, 4,4'-DDT, endrin, and heptachlor concentrations each exceeded the USEPA saltwater chronic and/or acute water quality criteria in at least one standard elutriate sample from the new work material:

- In the Bayou Casotte Channel elutriates, ammonia exceeded the chronic water quality criterion by factors ranging from 10.3 to 28.8 and the acute criterion by factors ranging from 1.5 to 4.3. In the Lower Pascagoula Channel elutriates, ammonia exceeded the chronic water quality criterion by factors ranging from 1.4 to 37.1 and the acute criterion by factors ranging from 3.5 to 5.6; Cyanide exceeded the USEPA acute and chronic water quality criteria in one elutriate (BCW-04) by a factor of 1.6;

- Copper concentrations in the standard elutriates exceeded the USEPA acute and chronic water quality criteria in three elutriate samples (BCW-01, BCW-03, and PLS-03/04) by factors ranging from 2.03 to 4.1 for the chronic criterion and 1.3 to 2.7 for the acute criterion;

- Nickel concentrations in the standard elutriates exceeded the USEPA chronic water quality criteria in one elutriate sample (BCW-03) by a factor of 1.05;

- The concentration of 4,4'-DDT at BCW-02 exceeded the chronic criterion by a factor of 6.7;

- The concentration of endrin at BCW-04 exceeded the chronic criterion by a factor of 3.4;

- The concentration of heptachlor in elutriates BCW-01 and BCW-02 the chronic water quality criterion by factors of 2.0 and 6.7.

Generally, the concentrations of metals in the standard elutriates were similar to those detected in the site water, and were much lower than the concentrations detected in the sediment. Therefore, the potential for release of metals into the water column during open-water placement is expected to be low. Organic constituents tested in the channels were infrequently detected, and the detected concentrations were generally low. None of the tested butyltins were detected in the standard elutriates. The majority of detected concentrations were greater than those in site water samples, and much lower than concentrations detected in sediments. Therefore, the release of organic constituents into the water column during open water placement is expected to be low because the organic constituents are bound tightly to the sediments.

2.5.3 Limiting Permissible Concentration (LPC) Compliance

For ocean placement to be a viable option for dredged material from the Bayou Casotte Harbor Channel Improvement Project, the dredged material must comply with Section 103 of the MPRSA. MPRSA states that any proposed placement of dredged material into ocean waters must be evaluated through the use of criteria published by the USEPA in Title 40 of the CFR, Parts 220-228 (40 CFR § 220-228). Sediments from the Pascagoula Harbor Channels were evaluated as to whether they met the regulations for ocean placement.

Compliance with Section 103 of the MPRSA includes determining the LPC compliance in four areas:

- water quality criteria,

- water column toxicity,

- benthic toxicity, and

- benthic bioaccumulation.

If LPC compliance is not met in one or more of these components, then the ocean placement requirements are not met. To determine whether the sediments from the Bayou Casotte Harbor Channel Improvement Project meet the LPC requirements, Short-Term Fate of Dredged Material (STFATE) modeling was conducted. The initial STFATE modeling assumed that 4,000 cys of dredged material would be placed at the center of the Pascagoula ODMDS during each placement event. Efficiency improvements in the dredging industry have resulted in larger hopper and scow containment sizes; therefore, to address those challenges, additional runs of the STFATE model to determine maximum load for the proposed improvement project assumed 7,000 cys within Bayou Casotte Channel and 9,000 cys within Lower Pascagoula Channel. For the future O&M project, STFATE model runs using quantities of 11,000 cys within Bayou Casotte Channel and 14,000 cys within Lower

Pascagoula Channel were also performed. Grain size and other physical characteristics of the sediment, as well as concentrations of receiving water, were used as input parameters. STFATE modeling determined the dilution factor of the plume 1 and 4 hours after placement, and how far the leading edge of the plume would travel within 4 hours after placement to ensure that the plume stayed within the boundaries of the placement site.

The actual location of placement within the Pascagoula ODMDS will be determined in coordination with USEPA-Region 4 and USACE-Mobile District prior to the start of dredging. According to the Pascagoula ODMDS Site Management Monitoring Plan (SMMP), placement shall occur no less than 330 feet inside the site boundaries such that the material and placement methods shall prevent mounding from becoming an unacceptable navigation hazard.

2.5.4 Water Quality Criteria

Standard elutriates were run using the sediment and site water from the project area. Standard elutriates are used to simulate the potential release of dissolved chemical constituents during ocean placement of dredged material. To determine whether the sediments from Bayou Casotte Harbor Improvement Project and future O&M activities meet the water quality criteria LPC requirements, STFATE modeling was conducted using the specifications of the placement site (i.e., dimensions and water column properties) to determine if the standard elutriate concentrations meet the LPC for ocean placement. The LPC for the water quality criteria is the concentration which:

1) does not exceed the water quality criteria outside the site boundary during the first 4-hours following placement, and

2) does not exceed the water quality criteria *anywhere* in the marine environment after 4-hours.

For the standard elutriates created from the sediment sampled from the Bayou Casotte Harbor Channel Improvement Project, comparisons to USEPA water quality criteria indicated that ammonia, cyanide, copper, nickel, 4,4'-DDT, endrin, and heptachlor were the constituents that exceeded acute and/or chronic water quality criteria for the protection of aquatic life. Of these analytes, ammonia in the sediment had the greatest potential to be released into the water column at elevated concentrations during open water placement. Therefore, two STFATE models – one for Bayou Casotte Channel and one for Lower Pascagoula Channel – were used to model the dilution rate for detected ammonia concentrations in Bayou Casotte and Lower Pascagoula Channel(s). The STFATE models were conducted using the specifications (i.e., dimensions and water column properties) of the placement site to confirm that sufficient dilution necessary to meet the water quality standards would be achieved within the 4-hour period inside the boundary of the Pascagoula ODMDS.

Based on the calculated acute and chronic ammonia criteria, a maximum 28.8-fold dilution of the full strength elutriate in Bayou Casotte would be required to comply with the acute and chronic ammonia criteria inside the boundary of the open-water placement site. Additionally, a maximum 37.1-fold dilution of the full strength elutriate from Lower Pascagoula Channel would be required to comply with the acute and chronic water quality criteria inside the boundary of the ODMDS.

2.5.4.1 *Bayou Casotte Improvements and O&M*

For Bayou Casotte Improvements, results of STFATE modeling indicated that a 9-fold dilution can be achieved within 1-hour following placement, and a 181-fold dilution would occur within 4-hours following placement at the Pascagoula ODMDS, which would be sufficient to achieve the dilution required to meet the acute and chronic water quality criteria for ammonia (and the acute and chronic

water quality criteria for the other exceeding constituents) for the standard elutriates from Bayou Casotte. The STFATE model (assuming a 7,000 cys placement event) indicated that 4-hours following placement, the leading edge of the plume was estimated to travel approximately 1,914 linear feet from the placement location, remaining well within the boundary of the Pascagoula ODMDS. For Bayou Casotte O&M, results of STFATE modeling indicated that a 51-fold dilution can be achieved within 1-hour following placement, and a 145-fold dilution would occur within 4-hours following placement at the Pascagoula ODMDS, which would be sufficient to achieve the dilution required to meet the acute and chronic water quality criteria for ammonia (and the acute and chronic water quality criteria for the other exceeding constituents) for the standard elutriates from Bayou Casotte. The STFATE model (assuming a 11,000 cys placement event) indicated that 4-hours following placement, the leading edge of the plume was estimated to travel approximately 1,914 linear feet from the placement location, remaining well within the boundary of the Pascagoula ODMDS. Therefore, the chemical constituents detected in the Pascagoula Bayou Casotte project elutriates achieved the LPC for placement at the Pascagoula ODMDS.

2.5.4.2 *Lower Pascagoula Channel Improvements and O&M*

For Lower Pascagoula Channel Improvements, results of STFATE modeling indicated that a 7-fold dilution can be achieved within 1-hour following placement, and a 168-fold dilution would occur within 4-hours following placement at the Pascagoula ODMDS, which would be sufficient to achieve the dilution required to meet the acute and chronic water quality criteria for ammonia (and the acute and chronic water quality criteria for the other exceeding constituents) for the standard elutriates from the Lower Pascagoula Channel. For Lower Pascagoula Channel O&M, results of STFATE modeling indicated that a 29-fold dilution can be achieved within 1-hour following placement, and a 160-fold dilution would occur within 4-hours following placement at the Pascagoula ODMDS, which would be sufficient to achieve the dilution required to meet the acute and chronic water quality criteria for ammonia (and the acute and chronic water quality criteria for the other exceeding constituents) for the standard elutriates from the Lower Pascagoula Channel. The STFATE model (assuming a 9,000 cys improvement placement event and 14,000 cys for the O&M placement event) indicated that 4-hours following placement, the leading edge of the plume was estimated to travel approximately 1,914 linear feet from the placement location, remaining well within the boundary of the Pascagoula ODMDS. Therefore, the chemical constituents detected in the Lower Pascagoula Channel project elutriates meet the LPC for water quality criteria.

2.5.5 Water Column Toxicity

Water column bioassays were conducted to evaluate the LPC for water column toxicity. The water column bioassay tests included 96-hour water column bioassays with *Americamysis bahia* (opossum shrimp) and *Menidia beryllina* (inland silverside), and 48-hour water column bioassays with *Mytilus edulis* (blue mussel). The purpose of the testing was to assess the effects of the potential dredged material on marine organisms. The bioassays evaluated the effects of exposure to the sediment elutriates on survival or normal embryo development of the test organisms. LC50s (Median Lethal Concentration) or EC50s (Effective Sub-Lethal Concentration) are calculated for each test. The LPC for the water column toxicity is the concentration that does not exceed 0.01 of the LC50/EC50 value (of the most sensitive test species) within a 4-hour mixing period inside the boundary of the placement site.

The survival in a few of the 100 percent elutriates for *M. beryllina* and *A. bahia* were significantly different than the control sample. However, each of the *M. beryllina* and *A. bahia* water column bioassays had 96-hour LC50s of greater than 100 percent elutriate. The *M. edulis* water column bioassay evaluates larval development, and was the most sensitive (thus restrictive) test conducted

on the elutriates. The EC50 concentrations for *M. edulis* were significantly different than the control sample for eight of the nine locations (PLS-05/06-SED was not significantly different). After 48 hours of exposure, the percent normal development in each of the 100 percent elutriate bioassays ranged from 0.6 to 79 percent normal development.

For water column bioassays, the LPC for ocean placement is equivalent to 0.01 of the EC50/LC50 within a 4-hour dilution period inside the boundary of the placement site (USEPA/USACE 1991). Based on the EC50s for *M. edulis*, a 173-fold dilution is required to meet the LPC compliance for water column toxicity in Bayou Casotte and a maximum 160-fold dilution is necessary for LPC compliance in the Lower Pascagoula Channel. Based on the STFATE modeling using a 4,000 cys placement volume, a 318-fold dilution would occur within the first four hours following placement for Bayou Casotte and a 415-fold dilution would occur within the first four hours following placement for Lower Pascagoula Sound. The plume remained inside the site boundary for each STFATE model. Based on the STFATE modeling results, the water column bioassays for the Bayou Casotte and Lower Pascagoula Channels meet the LPC for water column toxicity.

2.5.6 Benthic Toxicity

Whole sediment bioassays were conducted to evaluate the benthic toxicity LPC using sediment from each of the channels (USACE, 2011). Ten-day whole sediment bioassays were conducted using *Leptocheirus plumulosus* (estuarine amphipod) and *Neanthes arenaceodentata* (polychaete). Dredged material does not meet the benthic toxicity LPC when mean test organism mortality:

- is statistically greater than in the reference sediment, **AND**
- exceeds mortality (or other appropriate end point) in the reference sediment by at least 10 percent (or 20 percentage points for amphipods).

The whole sediment bioassay program for the samples from the Bayou Casotte Harbor Channel Improvement Project consisted of 10-day whole sediment bioassays with *N. arenaceodentata* and *L. plumulosus*. The purpose of the testing was to assess the effects of the potential dredged material on marine organisms. The bioassays evaluated the effects of exposure to the sediment elutriates on survival of the test organisms. Results indicated that sediments were not acutely toxic to *N. arenaceodentata* and *L. plumulosus*. None of the bioassays had significantly less survival than the Reference Site sediments. Therefore, sediments from the Pascagoula Harbor Channels meet the LPC for benthic toxicity for ocean placement.

2.5.7 Benthic Bioaccumulation

Whole sediment bioaccumulation studies were conducted to evaluate the potential for uptake of constituents from the sediment into organism tissue. *Nereis virens* (sand worm) and *Macoma nasuta* (blunt-nose clam) were exposed to sediment from the channels for 28 days. Following exposure to sediments from the Bayou Casotte Harbor Channel Improvement Project, tissue samples of *N. virens* (sand worm) and *M. nasuta* (clam) were analyzed for lipids (all samples), moisture content (all samples), metals (BCW-02, BCW-06, and PLS-03/04), and dioxin and furan congeners (BCW-05, BCW-06, and PLS-01/02). When tissue concentrations of contaminants of concern in organisms exposed to dredged material statistically exceed those of organisms exposed to the reference material, the dredged material has the potential to result in benthic bioaccumulation of contaminants. Dredged material does not meet the benthic bioaccumulation LPC if the tissue concentrations are statistically greater than U.S. Food and Drug Administration Action (USFDA)/Guidance/Tolerance Levels. If the tissue concentrations statistically exceed those of organisms exposed to the reference site, the bioaccumulation is evaluated to determine if placement of dredged material is likely to cause unacceptable bioaccumulation. The bioaccumulation tests evaluated the survival of the test organisms

and bioaccumlative effects as a result of exposure to the sediment samples. Survival results from the bioaccumulation tests with *N. virens* (sand worm) and *M. nasuta* (blunt-nose clam) indicated that after 28 days of exposure, none of the test sediments had significantly (p=0.05) lower survival than the reference sediment.

For the worms, two constituents – copper and octachlorodioxin (OCDD) – statistically exceeded reference site concentrations. For the clams, five constituents – arsenic, lead, 1,2,3,4,6,7,8-Heptachlorodibenzo-para-dioxin (HpCDD), OCDD, and the dioxin TEQ (ND=1/2RL) – statistically exceeded reference site concentrations. Tissue samples with mean concentrations that statistically exceeded the mean reference site concentrations were compared to pre-test tissue concentrations and to USEPA, Region 4 Background concentrations for the North Gulf of Mexico (USACE/USEPA 2008). In addition, mean concentrations were compared to the USFDA Action/Guidance/Tolerance Levels. None of the concentrations measured in the tissue samples exceeded the USFDA Action/Guidance/Tolerance levels. The tissue assessment for these constituents indicated:

- Few analytes in the channel tissues had mean concentrations that statistically exceeded both reference site and pre-test concentrations.

- Lead was the only metal which had a mean concentration (clam tissue at PLS-03/04) that statistically exceeded the mean reference site and mean pre-test concentrations. The mean lead concentration in clam tissue at PLS-03/04 (0.746 mg/kg) was also above the Region 4 Background concentration (0.47 mg/kg).

- None of the detected metals had UCLM (Upper Confidence Level of the Mean) values that exceeded the USFDA/USEPA Tolerance/Guidance levels.

- OCDD, the least potentially toxic and most ubiquitous dioxin congener (Toxicity Equivalency Factors (TEF) = 0.0003), was the only dioxin or furan congener which had a mean concentration that statistically exceeded both the mean reference site and pre-test concentrations.

- None of the dioxin TEQs exceeded both the reference site and pre-test dioxin TEQs, indicating that the few instances in which OCDD was detected in the clam and worm tissue at concentrations above both the reference and pre-test concentrations most likely do not represent levels that would produce a toxic effect.

Based on the assessment of metals and dioxin and furan congeners in tissues exposed to the sediments from the Pascagoula Harbor Navigation Channel Improvements Project and sediment from the reference site, it is anticipated that ocean placement of the dredged material at the Pascagoula ODMDS will not result in unacceptable bioaccumulation of contaminants. However, consultation and formal concurrence by USEPA, Region 4 would be required prior to placement to ensure that sediments from the Pascagoula Harbor Navigation Channel Improvements Project meet the LPC for benthic bioaccumulation, as required by 40 CFR Part 227.13 (c) (3). Sediments from Bayou Casotte and Lower Pascagoula Sound meet the LPC for WQC, water column toxicity, and benthic toxicity. However, consultation and formal concurrence by USEPA Region 4 would be required prior to placement to ensure that sediments from Bayou Casotte and Lower Pascagoula Sound meet the LPC for benthic bioaccumulation.

2.6 Commercial and Recreational Fishing

Gulf fisheries are some of the most productive in the world. In 2008 according to the NMFS, the commercial fish and shellfish harvest from the five U.S. Gulf states was estimated to be 1.3 billion

pounds valued at $661 million. The Gulf also contains four of the top seven fishing ports in the nation by weight and eight of the top 20 fishing ports in the nation by dollar value. Commercially-important species and species groups in the Gulf of Mexico include: blue crab, stone crab, crawfish, groupers, menhaden, mullets, oyster, shrimp, red snapper, and tunas.

Gulf landings of shrimp led the nation in 2008 with 188.8 million pounds valued at $367 million dockside, accounting for about 73 percent of U.S. total. Louisiana led all Gulf states with 89.3 million pounds; Texas with 63.8 million pounds; Alabama with 17.2 million pounds; Florida (west coast) with 9.9 million pounds; and Mississippi with 8.6 million pounds.

The Gulf led in production of oysters in 2008 with 20.6 million pounds of meats valued at $60.2 million and representing 59 percent of the national total. In 2006, Florida led the region in commercial fisheries-related sales and income, and generated more full- and part-time jobs than the other states. The commercial fishing industry in Florida generated $5.2 billion in sales, $2.9 billion in income and 103,000 jobs. The commercial fishing industries in Louisiana and Texas generated comparable economic activity. In Louisiana, commercial fishing generated $2.1 billion in sales, $1.1 in income, and supported 46,000 jobs. In Texas, the commercial fishing industry generated $2.2 billion in sales, $1.1 billion in income, and supported 47,000 jobs.

The Gulf also supports a productive recreational fishery. In 2008, marine recreational participants took more than 24.1 million trips catching 190 million fish from the Gulf of Mexico and surrounding waters. The total weight in pounds was over 73.6 million in 2008.

The 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, 2007b; MDMR, 2007d). 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 (NMFS, 2009c). Mississippi's annual commercial shrimp landings for 2009 were approximately 10 million pounds. The dockside value of this harvest, according to NMFS statistics for 2009, was approximately $12 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, 2007e). 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 takes shrimp samples to aid in determining the time to open shrimp season.

Juvenile shrimp develop in estuaries and, when mature, swim into the open Gulf where they spawn. Brown shrimp are most abundant from June to October and can be found in inshore and offshore waters. White shrimp are caught mostly during daylight hours in the fall months and can be found in shallower waters with mud bottoms. 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, 2007b).

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 (NMFS, 2009c). Blue crabs primarily inhabit brackish water. However, newly hatched crabs, called *zoeae*, spend their larval life in the offshore plankton. 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 in large numbers during the summer (MDMR, 2009c).

The Eastern oyster *(Crassostrea virginica)* is one of the more valuable resources of the Mississippi Gulf Coast. A total of over 2 million pounds of oysters worth $6,100,264 were collected in 2009 (NMFS, 2009c). Oysters 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 the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs (MDMR, 2009a).

2.6.1 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 the State of Mississippi. In 1999 Mississippi boat registration totaled 65,538 in the coastal counties; of those, 29,564 were registered for marine use (Burrage et al., 1999). The GSMFC reported 4,045 marine licenses sold in 2009 generating revenue of $373,896.00 for the State of Mississippi (GSMFC, 2010). NMFS tracks the economic impact of commercial and recreational fishing in the Gulf of Mexico. The major fisheries species that are regulated by the NMFS and the GMFMC for the Mississippi Gulf Coast are listed in Table 2.6.1-1 along with the 2009 landing statistics.

Pascagoula-Moss Point is the center of Mississippi's Gulf menhaden (*Brevoortia patronus*) fisheries industry, which accounts for the largest total landings of seafood in the state (MSU, 2007; NOAA, 2007b). The menhaden are used in the process of reduction fisheries to produce fish meal, fish oil, and condensed fish soluble, which are components in animal feeds, paints, plastics, and resins (MSU, 2007).

Table 2.6.1-1
2009 Commercial Fish Landing Statistics for Mississippi

Common Name	Species Name	Pounds	Dollars
Finfish			
Croaker, Atlantic	*Micropogonias undulatus*	105	$53
Drum, Black	*Pogonias cromis*	9,608	$2,926
Drum, Red	*Sciaenops ocellatus*	32,027	$50,432
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, Grey	*Lutjanus griseus*	1,440	$3,553
Snapper, Red	*Lutjanus campechanus*	57,264	$157,560
Tripletail	*Lobotes surinamensis*	935	$1,667
Shellfish			
Crab, Blue	*Callinectes sapidus*	545,328	$572,852
Oyster, Eastern	*Crassostrea virginica*	2,191,724	$6,100,264
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
	Total(s)	**229,796,417**	**$37,756,809**

Source: NMFS, 2011c

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 is for king mackerel and suggests 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, 2007d).

2.6.2 Shellfish

The common commercial and recreational shellfish of the Mississippi coastal region are listed on Table 2.6.2-1. 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, 2007b; MDMR, 2007d).

Table 2.6.2-1
Common Mississippi Shellfish Fisheries

Species Name	Common Name
Callinectes sapidus	Blue Crab
Crassostrea virginica	Eastern Oyster
Penaeus aztecus	Brown Shrimp
Penaeus duorarum	Pink Shrimp
Penaeus setiferus	White Shrimp

Source: MDMR, 2007b; MDMR 2007e.

2.6.2.1 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 (NMFS, 2009c). Mississippi's annual commercial shrimp landings for 2009 were approximately 10 million pounds. The dockside value of this harvest, according to NMFS statistics for 2009, was approximately $12 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, 2007e).

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 takes shrimp samples to aid in determining the time to open shrimp season.

Juvenile shrimp develop in estuaries and, when mature, swim into the open Gulf where they spawn. Brown shrimp are most abundant from June to October and can be found in inshore and offshore waters. White shrimp are caught mostly during daylight hours in the fall months and can be found in shallower waters with mud bottoms. 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, 2007b).

2.6.2.2 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 (NMFS, 2009c). Blue crabs primarily inhabit brackish water. However, newly hatched crabs, called zoeae, spend their larval life in the offshore plankton. 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 in large numbers during the summer (MDMR, 2007c).

2.6.2.3 Oysters

The Eastern oyster *(Crassostrea virginica)* is one of the more valuable resources of the Mississippi Gulf Coast. A total of over 2 million pounds of oysters worth $6,100,264 were collected in 2009 (NMFS, 2009c). Oysters 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 the western Mississippi Sound, primarily from Pass Marianne, Telegraph, and Pass Christian reefs (MDMR, 2007a).

2.6.3 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 bycatch from fishing trawls. The conchs, sand dollars, and sea biscuits taken along the Gulf are generally used for souvenirs in the tourism industry.

2.7 Essential Fish Habitat

The MFCMA was passed to promote sustainable fish conservation and management. Under the MFCMA, the NMFS 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 (EEZ) depending on geographic location. The NMFS was also granted legislative authority to establish eight regional FMCs 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 (FMPs) prepared by the eight councils for their respective geographic regions. The Mississippi Sound system and nearshore Gulf of Mexico is within the management jurisdiction of the GMFMC.

The NMFS recognized that many marine fisheries are dependent on nearshore and estuarine environments for at least part of their life cycles. The MFCMA was reauthorized and changed extensively via amendments in 1996 (16 U.S.C. § 1801 Pub. L. No. 104-297, October 11, 1996), which aimed to stress the importance of habitat protection to healthy fisheries. The authority of the NMFS 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 MFCMA and are defined as “those waters and substrate necessary to fish for spawning, breeding, feeding or growth to maturity” (16 U.S.C. § 1802 (10)). The EFH regulations (at 50 CFR 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 located in Appendix E.

2.7.1 Species Accounts

The 1998 and 2005 Generic Amendments for addressing EFH requirements in the FMPs for shrimp, red drum, reef fish, coastal migratory pelagic resources, stone crab, spiny lobster, and coral and coral reefs; the 2004 EIS for shrimp, red drum, reef fish, coastal migratory pelagic resources, stone crab, spiny lobster, and coral and coral reefs; the *2006 Consolidated Atlantic Highly Migratory Species Fishery Management Plan* and the *2009 Amendment 1 to the Consolidated Atlantic Highly Migratory Species (HMS) Fishery Management Plan* were used as resources to describe the life history and preferred habitat of managed species with EFH designated within the project area (GMFMC, 1998; GMFMC, 2004; GMFMC, 2005). Relative abundance information was obtained from Estuarine Living Marine Resources (ELMR) and the National Coastal Data Development Center Coastal Ecosystem Gulf of Mexico data.

2.7.1.1 Red Drum Fishery

The red drum occurs throughout the Gulf of Mexico in a variety of habitats, ranging from depths of about 130 feet offshore to very shallow estuarine waters. They 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 130 to 230 feet (NMFS, 2004). 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. 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 the Mississippi Sound, juvenile red drums are relatively common year-round and adults are relatively common from February to October.

2.7.1.2 Shrimp Fishery

Brown, white, and pink shrimp have the potential to occur in the vicinity of the Pascagoula Harbor Navigation Channel. A description of the life histories of the three shrimp species and their seasonal movements is presented in Section 2.3.5.

2.7.1.3 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 590 feet. Adults are demersal and mid-water dwellers, occurring in marine, estuarine, and riverine habitats. They occur up to 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 grassbeds 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.

The gray triggerfish are found throughout the Gulf of Mexico. Eggs occur 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 to 7 inches) move to reef habitat on the bottom. Adults are found offshore in waters greater than 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 depth greater than 33 feet.

Lane snapper occur throughout the shelf area of the Gulf in depths ranging from 0 to 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 the mangrove and grassy estuarine areas in southern Texas and Florida and shallow areas with sandy and muddy bottoms off all Gulf states. Early and late juveniles appear to favor grass flats, reefs, and soft bottom areas to offshore depths of 66 feet (NOAA, 1985). Adults occur offshore at depths of 13 to 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 656 feet. Adults favor deeper water in the northern Gulf. Spawning occurs in offshore waters from May to October at depths of 59 to 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 July through November in shelf waters ranging in depth of 55 to 600 feet. Early and late juveniles are often associated with structures, objects, or small burrows, but also are abundant over barren sand and mud bottom. Late juveniles are taken year-round at depths of 65 to 130 feet.

2.7.1.4 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 3 to 230 feet. Adults feed on fishes and crustaceans, including crabs. Spawning occurs in coastal waters from April through September at temperatures ranging from 73.4º to 82.4ºF. These fish migrate seasonally, and are commonly seen among other species in the family. Eggs are found in the few feet 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 68º F. While adults can be found at the shelf edge in depths to

656 feet, they generally occur at depths less than 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 outer continental shelf 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 115-591 feet in spring and summer. Larvae occur over the middle and outer continental shelf, 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 greater than 68°F and out to depths of 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 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 the Mississippi Sound from spring through fall.

2.7.1.5 Highly Migratory Species

Mississippi Sound and adjacent waters have been identified as important nursery areas for nine sharks, primarily Atlantic sharpnose, blacktip, finetooth, and bull sharks. Other less common species are the spinner, blacknose, sandbar, bonnethead, and scalloped hammerhead. EFH has been identified in this area for the blacknose, Atlantic sharpnose, bonnethead, tiger, spinner, bull shark, 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 located 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.

2.8 Marine Sanctuaries

The National Marine Sanctuary System consists of 14 marine protected areas that range from less than 1 square mile to 137,792 square miles of ocean and Great Lakes waters (NOAA, 2007c). Two national marine sanctuaries are located in the Gulf; however, both are far from the project study area. The Flower Gardens Bank National Marine Sanctuary is located in the western portion of the Gulf,

approximately 110 miles off the coasts of Texas and Louisiana. The Florida Keys National Marine Sanctuary is located off the southern tip of Florida (NOAA, 2007d).

2.9 Permitted Surface Water Discharges

There are currently eight active NPDES Water Discharge Permits within the Pascagoula Harbor, Bayou Casotte Navigation Channel. (MDEQ, 2012)

Chevron Products Company, Pascagoula Refinery, (#MS0001481, from 4/26/2012 to 3/31/2017), allows the outfall of treated process wastewater, stormwater from process area, various tank fields, washdown water, hydrotest water, and fire water and stormwater runoff and decant water from the dredged material area. The receiving waters are the Mississippi Sound and one discharge directly into Bayou Casotte.

The Gulf LNG Energy LLC - LNG Clean Energy Project permit, (#MS0060518, from 2/9/2007 to 1/31/2012; extended while processing new application), allows the outfall of process wastewater, including discharge from the LNG import terminal, as well as stormwater discharge. These two outfalls discharge into an adjacent wetland of Bayou Casotte and into Mississippi Sound.

Huntington Ingalls Inc., Ingalls Shipbuilding Division permit, (#MS0003069 from 7/14/2009 to 6/30/2014), allows for stormwater runoff and deballasting (drydock) from multiple outfalls into Pascagoula Bay, Pascagoula River, and Community Bayou.

The Jackson County Utility Authority, Pascagoula Publicly Owned Treatment Works permit, (#MS0020249, from 5/1/2012 to 4/30/2017), allows discharge of domestic/municipal wastewater. The Authority is required to enact and comply with a Mercury Minimization Plan, as well as Sludge Management and Municipal Pretreatment Plan Requirements.

Mississippi Phosphates Corporation, (#MS0003115 from 11/10/2009 to 10/31/2014), allows stormwater runoff from non-process area, shops, offices, roads, railroads, and lawns and various locations around Closed and Active Gypsum Storage Pile Perimeters, storm water and Cooling Ditch into Bayou Casotte and Mississippi Sound.

The Pascagoula Water Treatment Plant (WTP), Community Avenue permit (#MS0055379, from 5/7/2007 to 2/28/2012; extended while processing new application), to allow the outfall of treated backwash. Pascagoula WTP, Bayou Casotte permit (#MS0055387, from 11/7/2005 to 10/31/2010; extended while processing new application), allows the discharge of filtered potable water remnants.

Rolls Royce Naval Marine Inc. permit (#MS0057932 from 6/20/2011 to 5/31/2016), allows one outfall structure for the discharge of domestic wastewater into an unnamed tributary of Bayou Casotte with stated discharge limitations and required monitoring.

Signet Maritime Corporation, also known as The Colle Towing Company, Inc. permit, (#MS0048445, from 8/19/2010 to 7/31/2013), allows the discharge of sanitary wastewater from the company's dock and office. This permit does not allow an accumulation of solids or sewage sludges in the receiving stream or the discharge of oil or other petroleum products.

2.10 Cultural and Archaeological Resources

Cultural resources are prehistoric and historic sites, archaeological sites, shipwrecks, structures, districts, or other physical evidence of human activity considered important to a culture, subculture, or community for traditional, religious, or scientific reasons. These include locations of concern to Native American groups, including Traditional Cultural Properties.

Legislative mandates, including but not limited to Section 106 of the NHPA, as amended (16 U.S.C. § 470 et seq. in compliance with 36 CFR § 800), the NEPA, as amended (42 U.S.C. § 4321–4347), and the Archaeological Resources Protection Act (ARPA) of 1979, as amended (16 U.S.C. § 470aa–mm) require Federal agencies to assess potential effects Federal actions may have on districts, sites, buildings, structures, or objects included, or eligible to be included, in the National Register of Historic Places (NRHP).

To be eligible for NRHP listing, an archaeological site or other property must satisfy at least one of the National Register criteria as set forth in 36 CFR § 60.4. The site or property must possess integrity of location, design, setting, materials, workmanship, feeling, and association as well as:

- Be associated with events that have made a significant contribution to the broad patterns of our history; or
- Be associated with the lives of persons significant in our past; or
- Embody the distinctive characteristics of a type, period, or method of construction, or a significant and distinguishable entity whose components may lack individual distinction; or
- Have yielded, or may be likely to yield, information in prehistory or history.

As per requirements outlined in Section 106 of the NHPA, the USACE, Mobile District must consider the effects of an action on cultural resources, specifically those that meet the definition of "*historic properties*". *Historic properties*, as defined by the NHPA, are cultural resources that are listed on or are eligible for inclusion on the NRHP.

2.10.1 Previous Investigations

The Mississippi Gulf Coast is rich in cultural and historical resources. Numerous prehistoric and historic period archaeological sites, standing structures, and submerged sites (most notably shipwrecks) are recorded. The area in and around Bayou Casotte is typical of the coast in terms of historic activity and resources. Bayou Casotte and the Pascagoula Lower Sound Channels of Pascagoula Harbor are in the Coastal Pine Meadows archaeological region, which includes the southernmost portions of Jackson and Harrison Counties, the southern and western portion of Hancock County, and the westernmost portion of Pearl River County. This region is unique because of its cultures' coastal adaptations to focus on marine and estuarine resources and has been continuously occupied since prehistoric times. As such, numerous studies have been undertaken in the study area to determine the effect of proposed projects on cultural resources.

Due to the known resources and compliance regulations, several studies have previously been conducted to identify historic properties at Bayou Casotte. These studies include the "*Archaeological Survey and Testing of Greenwood Island and the Bayou Casotte Proposed Port Facilities, Jackson County, Mississippi*" (Solis and Walling 1982) and the "*Cultural Resources Reconnaissance of Pascagoula Harbor, Mississippi*" (Mistovich et al. 1983). The 1982 study consisted of a terrestrial survey and archaeological testing of the proposed Bayou Casotte Port. The 1983 study included a marine survey of the Pascagoula Harbor Navigation Channel which includes the navigation channel into Bayou Casotte.

One of the earlier investigations of the area was undertaken in 1983 by OSM Archaeological Consultants, Inc. A cultural resources reconnaissance of Pascagoula Harbor (both terrestrial and marine) was conducted in order to "provide a baseline study of the prehistoric and historic human use and occupation of this southeast Mississippi locale." The study resulted in the relocation or attempted relocation of six previously recorded archaeological sites (22JA516, 22JA618, 22JA537, 22JA522, 22JA523, and 22JA592) as well as the recording of three historic sites that were not assigned

trinomials by the MDAH due to their recent age. The results of the findings as it pertains to shipwrecks are discussed in Mistovich et al. 1983.

In 2005, Gulf LNG Energy, LLC, proposed to site, construct, and operate a LNG terminal adjacent to Bayou Casotte Harbor. Site 22JK674 and a historic district in downtown Pascagoula were the nearest archaeological site and architectural properties identified, respectively. In consultation with the Federal Energy Regulatory Commission (FERC) and the MDAH, it was concluded that the proposed project would not affect any properties listed or eligible for listing in the NRHP (FERC 2006).

Studies were also undertaken for the USACE, Mobile District's proposed construction of authorized improvements to the Pascagoula Harbor Navigation Channel. Although numerous shipwrecks occurred along the Gulf shoreline, no NRHP-designated sites were identified within their project study area. While two historic shipwrecks (*Jerry Ann and Gee Bee*) were identified near the project area, neither shipwreck was listed in the NRHP. Three additional shipwrecks were identified as being in the vicinity of the proposed Area of Potential Effect (APE), including two (*Angler and Arcturus*) west of the LZPA south of Horn Island and one (*Wanda Four*) near the LZPA. Because the resources identified were not within the proposed APE, it was concluded that none of the resources would be affected by the improvement project (USACE 2010).

The USACE, Mobile District also conducted studies relating to the proposed improvements to the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels. A number of prehistoric archaeological sites and historic archaeological sites have been recorded along the bayou - including the Big and Little Greenwood Island sites (22JA516 and 22JA618) and a post-Mexican War hospital and burial site associated with Camp Jefferson Davis. These sites were studied during a 1982 terrestrial survey and archaeological testing of the proposed Bayou Casotte Port. The following year, a terrestrial and marine survey of Pascagoula Harbor and the Pascagoula Harbor Navigation Channel was conducted in which the sites were discussed further (Mistovich et al. 1983). It was recommended that the remaining burials be located, removed and reinterred along with minimal mitigation of the two archaeological sites. A 2016 review of the previous studies and other data by USACE, Mobile District's archaeologists identified magnetic anomalies located by the Mistovich et al. survey (1983) that exhibited characteristics consistent with historic shipwrecks in Bayou Casotte. These were recommended for further evaluation in the initial survey report, but that work was not carried out at that time. As a result, USACE contracted 'SEARCH' to dive the target locations for verification of the significance of the anomalies. The work completed in March 2017 yielded sufficient data to determine the targets were modern debris without historical significance.

2.10.2 Results of Records Review

As part of the USACE, Mobile District's Regulatory Division EIS efforts, additional background research and field studies were conducted.

The APE includes several archaeological sites, including the Big and Little Greenwood Island sites (22JA516 and 22JA618) and a post-Mexican War hospital and burial site associated with Camp Jefferson Davis (Bradley 2011). Additionally, the MDAH noted that USM had recently done work on Greenwood Island and they had received "a significant collection from Greenwood Island in the last 2 years" (Williamson 2011a).

Recent attempts to relocate 22JA618 have failed. No further testing of 22JA618 was possible as the site has likely completely eroded or has been covered with dredged material. The USACE, Mobile District recently conducted Phase II testing at site 22JA516 (Bradley 2011, Williamson 2011b). In fall 2011, Phase II testing of site 22JA516 was conducted by Brockington and Associates, Inc., on behalf of the USACE, Mobile District for the proposed improvements. During the excavation, a substantial area of intact and partially intact prehistoric midden was identified. The USACE, Mobile District

determined that the site was eligible for inclusion in the NRHP under Criterion D, for its potential to produce important information regarding local and regional prehistoric occupation, including prehistoric cultural chronology, subsistence patterns, intrasite use and mortuary practices (RabbySmith 2012). This site is being mitigated under a Memorandum of Agreement with the Mississippi State Historic Preservation Officer, the USACE Regulatory and Planning Divisions, the Choctaw Nation of Oklahoma, and the Advisory Council on Historic Preservation (see MOA in Appendix F).

Prior to the investigation by RabbySmith, 2012, Earth Search, Inc. conducted a remote-sensing survey and subsurface probing of the Mexican War-era graveyard associated with Camp Jefferson Davis. Prior to their investigation, seven to nine graves were believed to be present in the burial site, of which six had been previously identified and removed. During the current investigation's probing, a single submerged coffin was identified. The coffin was believed to be associated with one of the previously excavated burials in which during the excavation, the coffins were left in situ. Although the number of graves originally interred at the burial site is unclear, based on the results of the current survey, Earth Search believed no other intact coffins remained in their project area and recommended no further work to the Mexican War-era graveyard (RabbySmith 2012).

Shipwrecks

The Mistovich et al. survey (1983) identified 11 individual magnetic anomalies or clusters of magnetic anomalies that they determined required additional investigation to determine whether or not they represented historic shipwrecks or modern debris. There were no associated acoustic targets associated with the magnetic anomalies. Prior to construction, these anomalies were investigated and determined to not be eligible for the NRHP.

During a 2010 study undertaken for the USACE entitled, *Authorized Improvements to the Pascagoula Harbor Navigation Channel* (USACE 2010), the Office of Coast Survey's Automated Wreck and Obstruction Information System (AWOIS) database showed the *Sea Bee* in the vicinity of the proposed project.

Further research showed that the fishing vessel *Sea Bee* was included in the Local Notice to Mariners 42-80 (the 42nd report for the year 1980, 3rd week of October) which stated that "the 38-foot fishing vessel *Sea Bee* previously reported sunk in approximate position 30 –18.2N, 88 –30.5W with 2 feet of the vessel above the water has been salvaged. Portions of the vessel have been reported in an area 300 feet northeast of Bayou Casotte Light 8." The NOAA Chart 11375, published on November 5, 1983, indicated an obstruction in the vicinity of the *Sea Bee* was not present when the chart was published on July 12, 1980. This would indicate that the obstruction on the chart was plotted after July 1980, which is in line with the October 1980 salvage of the *Sea Bee* as indicated in the referenced notice to mariners.

Background information indicated that the *Sea Bee* is a modern vessel, which sunk in 1980 and has been partially salvaged. As such, the *Sea Bee* would not meet the minimum requirements for inclusion in the NRHP, and no further investigation would be warranted.

2.11 Noise

The project study area is surrounded by industrial activities nearshore and open water offshore. Current sources of noise include existing industrial and shipping activities that are active year-round. In the Pascagoula Harbor, sources of those activities include the Port of Pascagoula, Chevron, Mississippi Phosphates Corporation, VT Halter Marine, NOAA, Gulf LNG Energy, and the USCG.

The Port of Pascagoula was ranked 22nd in the U.S. in tonnage, handling more than 34 million tons of cargo. In 2016, over 35 million tons of cargo move through the port annually and it is a major U.S. port consistently ranking as a top 20 port in the nation for foreign cargo volume. Shipping, industrial operations, and handling the cargo generates background noise at the Port and at other industries with shipping operations in the area. Noise studies at other ports have identified an ambient noise level of 55 to 70 decibels (dBA) depending on location relative to port activities, and peak noises exceeding 100 dBA have occurred in association with the use of heavy equipment (Port of Los Angeles 2006).

None of the industrial operations surrounding the ship channel could be considered sensitive to noise. Tourist boats and small personal craft operate out of the Port of Pascagoula. However, these are also not considered noise-sensitive receptors. The closest residential area, zoned as R1A, is located along the coastline near the near the Pascagoula Beach, Mississippi Sound, and Bayou Casotte. Five schools are located within a 1-mile radius of the project study area, including Beach Elementary School, Trent Lott Middle School, Central Elementary School, Resurrection Middle High School, and Bethel Academy and Daycare [Environmental Systems Research Institute (ESRI) 2005].

Marine shipping activities produce underwater noise, typically low-frequency sounds in the range of 20-500 hertz (Hz), resulting from operation of engines and propellers [University of Rhode Island (URI) 2003]. Shipping to the ports of Louisiana and Mississippi includes approximately 8,000 to 9,000 foreign cargo vessel trips per year (UD 2006), and shipping traffic throughout the GIWW exceeds 700,000 vessel trips per year (USACE 2004). Low-frequency sound travels farther underwater than higher-frequency sound, so underwater shipping noise from this traffic extends beyond the immediate vicinity of the Bayou Casotte Harbor Navigation Channel.

To better assess potential species effects (i.e., disturbance of communication among marine mammals) associated with dredge specific noise from navigation maintenance widening, or placement activities, Clarke et al. (2002) performed underwater field investigations to characterize sounds emitted by bucket, hydraulic cutterhead, and hopper dredge operations. A summary of results from the study are presented below and are a first step toward developing a dredge sounds database that will encompass a range of dredge plant sizes and operational features:

Cutterhead Suction Dredge
Noise generated by a cutterhead suction dredge is continuous and muted and results from the cutterhead rotating within the bottom sediment and from the pumps used to transport the effluent to the placement area. The majority of the sound generated was from 70 to 1,000 Hz and peaked at 100 to 110 dBA range. Although attenuation calculations were not completed, reported field observations indicate that the cutterhead suction dredge became almost inaudible at about 500 meters (Clarke et al., 2002).

Hopper Dredge
The noise generated from a hopper dredge is similar to a cutterhead suction dredge except there is no rotating cutterhead. The majority of the noise is generated from the drag arm sliding along the bottom, the pumps filling the hopper, and operation of the ship engine/propeller. Similar to the cutterhead suction dredge, most of the produced sound energy fell within the 70- to 1,000-Hz range; however peak pressure levels were at 120 to 140 dB (Clarke et al., 2002).

Bucket Dredge
Bucket dredges are relatively stationary and produce a repetitive sequence of sounds generated by winches, bucket impact with the substrate, bucket closing, and bucket emptying. The noise generated from a mechanical dredge entails lowering the open bucket through the water column, closing the bucket after impact on the bottom, lifting the closed bucket up through the water column, and emptying the bucket into an adjacent barge. On the basis of the data collected for this study, which included

dredging of coarse sands and gravel, the maximum noise spike occurs when the bucket hits the bottom (120 dB peak amplitude). A reduction of 30 dB re 1 µPa/m occurred between the 150 m and 5,000 m listening stations with faintly audible sounds at 7 km. All other noises from the operation (i.e., winch motor, spuds) were relatively insignificant (Clarke et al., 2002).

2.12 Air Quality

Existing air quality conditions near the project study area reflect the ongoing industrial and commercial operations in the immediate vicinity, as well as surrounding traffic and residential outputs (*Appendix G – Air Quality*).

The MDEQ is responsible for protecting the state's air, land, and water. The MDEQ, Air Division is responsible for ensuring that air quality within Mississippi is protective of public health and welfare. This division is charged with controlling, preventing, and abating air pollution to achieve compliance with air emission regulations pursuant to the Mississippi Air and Water Pollution Control Act, applicable regulations promulgated by the USEPA, and the Federal Clean Air Act.

2.12.1 Air Pollutant Standards

The Ambient Air Quality Standards for Mississippi are in Regulation APC-S-4 as described in the following: **MISSISSIPPI COMMISSION ON ENVIRONMENTAL QUALITY** ("the Commission") **REGULATION APC-S-4: AMBIENT AIR QUALITY STANDARDS** (as adopted February 9, 1983 and last amended June 27, 2002)

Except for odor, as covered below, the ambient air quality standards for Mississippi shall be the Primary and Secondary National Ambient Air Quality Standards (NAAQS) as duly promulgated by USEPA in (or to be printed in) 40 CFR Part 50, pursuant to the Federal CAA, as amended. All such standards promulgated by USEPA as of June 22, 1988, are hereby adopted and incorporated herein by the Commission by reference as the official ambient air quality standards of the State of Mississippi and shall hereafter be enforceable as such (except that the word "Administrator" in said standards shall be replaced by the words "Executive Director" and the word "Agency" in said standards shall be replaced by the word "Department").

There shall be no odorous substances in the ambient air in concentrations sufficient to adversely and unreasonably:

(1) affect human health and well-being;

(2) interfere with the use or enjoyment of property; or

(3) affect plant or animal life.

In determining that concentrations of such substances in the ambient air are adversely and unreasonably affecting human well-being or the use or enjoyment of property of plant or animal life, the factors to be considered by the Commission will include, without limiting the generality of the foregoing, the number of complaints or petitioners alleging that such a condition exists, the frequency of the occurrence of such substances in the ambient air as confirmed by the MDEQ staff, and the land use of the affected area.

Mississippi has adopted Federal Standards (New Source Performance Standards, National Emissions Standards for Hazardous Air Pollutants, etc.) by reference. State specific emissions standards for Mississippi are in:

- Regulation APC-S-1 - Air Emission Regulations for the Prevention, Abatement, and Control of Air Contaminants; and

- Regulation APC-S-8 - Air Toxic Regulations.

2.12.2 Emissions Sources

2.12.2.1 Significant Stationary Sources

Major stationary sources, or point sources, of air pollution are required to obtain a Title V operating permit, which establishes all air requirements applicable to the source and specifies the methodology for the emitting source to demonstrate compliance.

Air permits have been issued for 13 facilities located in Jackson County, of which 8 are located in Pascagoula. Of the 13 facilities, 7 have reported toxic releases as of 2009 and are listed in the USEPA toxic release inventory. Of the facilities located in Pascagoula, Chevron Products Co, Pascagoula Refinery is the largest overall emitter. The permitted facilities include:

- Chevron Products Co., Pascagoula Refinery
- Destin Pipeline Company, LLC
- First Chemical Corporation
- Huntington Ingalls Inc., Ingalls Shipbuilding Division
- Macland Disposal Center, Inc
- Mississippi Phosphates Corporation
- Mississippi Power Company, Chevron Cogenerating Plant
- Mississippi Power Company, Plant Victor J. Daniel
- VT Halter Marine, HMP, MPM, and Pascagoula Operations

The constituents released most frequently and in the greatest amounts include: hydrogen chloride, ammonia, hydrogen fluoride, sulfuric acid, benzene, carbonyl sulfide, ethylene, ethylene glycol, xylene, n-hexane, propylene, toluene, and methanol (USEPA 2009).

2.12.2.2 Mobile Sources

Shipping traffic and vehicular land traffic contribute to mobile sources in and around the project study area. Major traffic areas are located along U.S. 90. After vessel unloading, cargo is moved by rail and highway, and these mobile sources contribute air emissions. Cargo from the shipping vessels is moved by rail (CSX Transportation, Inc. and the Mississippi Export Railroad, which connect to the Canadian National Railroad) and truck (via U.S. 90 and Interstate-10) from the Port of Pascagoula. Except for the trucks, ground vehicle use in the area is mostly pass-through traffic and contributes only minimally to air pollution. Most of the mobile air pollution in the vicinity is a result of highway traffic. The 2005 highest annual average daily traffic count within the vicinity of the project study area was northeast of the Port of Pascagoula on the U.S. 90 bridge crossing the Pascagoula River, with a count of 41,000 [Mississippi Department of Transportation (MDOT) 2005].

2.12.2.3 Dredging Sources

Dredging activities contribute air emissions periodically in and around the project study area. Total emissions vary based on the duration of dredging activities and type of equipment used. Estimates of standard emission rates for diesel-powered dredging vessels are shown in Table 2.12.2.3-1.

Table 2.12.2.3-1
Emission Factors for Dredging Vessels

Operating Mode	PM (lb/Mgal)	TOG (lb/Mgal)	NOx (lb/Mgal)	SOx (lb/Mgal)	CO (lb/Mgal)
<500 HP					
Full (80 Percent Power)	17	21	275.1	125.6	58.5
Cruise (50 Percent Power)	17	51.1	389.3	125.6	47.3
Slow (20 Percent Power)	17	56.7	337.5	125.6	59
500 – 1,000 HP					
Full (80 Percent Power)	17	24	300	125.6	61
Cruise (50 Percent Power)	17	17.1	300	125.6	80.9
Slow (20 Percent 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; HP = horsepower
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 scenario, approximately 50,912 gallons of fuel would be consumed and annual emissions for a 1,000 hp dredge would be:

- 0.86 tons PM
- 0.85 to 1.22 tons TOG
- 8.5 to 15.3 tons NOx
- 6.4 tons SOx
- 3.1 to 4.1 tons CO

2.13 Socio-Economics

2.13.1 Land-Use and Land Cover

The Port of Pascagoula is located approximately 10 miles south of Interstate-10, encompasses approximately 214 acres, and is bounded to the north by U.S. Highway 90, to the east by U.S. Highway 63, and to the west by Pascagoula Bay. The Port of Pascagoula has two harbors: the Bayou Casotte Harbor and the Pascagoula River Harbor. The Port is zoned for industrial and special uses. Rail service begins at the terminals of the Pascagoula River and Bayou Casotte Harbors and rail spur comes in from Pascagoula. Cargo is distributed from the Port via rail and trucking services. Rail service includes CSX Transportation, and the Mississippi Export Railroad, which connects to Canadian National Railroad. Trucking services use highway connections, including Interstate 10 and U.S. Highway 90. Roads connecting the Port to U.S. Highway 90 and beyond include Port River Road and Plymouth Road, also known as Jerry Street PE Highway.

The Port owns and operates public cargo facilities at its two harbors, the Pascagoula River Harbor and Bayou Casotte Harbor, and contains nine deepwater berths and one barge berth. 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.

The Port of Pascagoula is zoned industrial and is located on a peninsula surrounded on the west and the south by the Pascagoula Channel. The eastern boundary of the Port is adjacent to the City of Pascagoula, which includes both residential and commercial land use. These zoning districts include industrial, commercial, and residential areas. Land and water areas for the region of influence are listed in Table 2.13.1-1.

Table 2.13.1-1
Land and Water Areas by Port of Pascagoula, City, County, and State

	Land Area[a] (square miles)	Sound and/or Inland Water or Water Area (square miles)
Port of Pascagoula	33.4[b]	N/A[c]
Pascagoula	15.2	N/A
Jackson County	726.9	316.4
Biloxi	38.0	N/A
Gulfport	56.9	9.02[d]
Baton Rouge	76.8	N/A
New Orleans	180.6	N/A
Mobile	117.9	N/A
Pensacola	22.7	N/A
Harrison County	581.0	395.2
Hancock County	476.9	75.6
Mississippi	47,233	456
Louisiana	44,521	3,230
Alabama	50,767	938
Florida	54,153	4,511

Sources:
[a] City-data.com
[b] The Mississippi Legislature Joint Committee on Performance Evaluation and Expenditure Review. The value represents both land and water.
[c] Not Available.
[d] Lusteck, Joseph A. & Associates, Inc. Real Estate and Planning Consultants.

2.13.2 Utilities

The City of Pascagoula and the Port of Pascagoula are served by Mississippi Power Company and Singing River Electric Power Association for electricity, Pascagoula Utilities Department for natural gas, water, and sewer services, and BellSouth for telephone service. Utility services for areas surrounding Pascagoula, including Jackson, Harrison, George, and Mobile Counties, are summarized in Table 2.13.2-1 (Sun Herald 2016; Mobile Area Chamber of Commerce 2016).

Table 2.13.2-1
Utility Services for Jackson, Harrison, and George County, Mississippi, and for Mobile County, Alabama

County Name	Electricity	Natural Gas	Water and/or Sewer	Telephone
Jackson	Mississippi Power Company, and 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	BellSouth
Harrison	Coast Electric Power Association, and Mississippi Power Company	Center Point Energy	Gulfport Water and Sewer Department, Orange Grove Utilities, Eco Resources, Westwick Utilities, City of D'Iberville Water and Sewer Department, Long Beach Water Department, and Pass Christian Utilities Department	BellSouth
George	Mississippi Power Company and Singing River Electric Power Association	Atmos Energy	Rocky Creek Utilities, Southeast Greene Water Authority, and Estabuchie Utility Association	BellSouth
Mobile	Alabama Power, Baldwin County Electric, and Riviera Utilities	Mobile Gas Service Corporation, and South Alabama Utilities	Mobile Water and Sewer System, South Alabama Utilities, and Mobile County Water Department	BellSouth

Sources: Sunherald, 2016 and the Mobile Area Chamber of Commerce, 2016.

According to The Mississippi Press, Singing River Electric Power Association provided electricity to 46,104 customers in Jackson County prior to Hurricane Katrina and 49,545 customers thereafter. Pascagoula customers of Singing River Electric Power Association totaled 6,125 prior to Hurricane Katrina and 5,657 afterward. Pascagoula customers of Mississippi Power Company totaled 8,407 prior to Hurricane Katrina and 6,654 thereafter (Singing River Electric Power Association and Mississippi Power 2016). Offshore, gas pipelines cross Mississippi Sound, including a portion of the Upper Pascagoula Channel.

Approximately 88 community water systems provide potable water to the tri-county area of the Mississippi Gulf Coast. The water they provide is available for residential, commercial, industrial, and agricultural use, including landscape irrigation, and it is delivered by a system of wells, water distribution piping, and water storage tanks that together make-up the water supply infrastructure of coastal Mississippi. 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. The inland portions of the three-county region are largely without public water systems. Throughout the entire state of Mississippi, increased pumping rates has altered the natural groundwater flow direction. The natural groundwater flow direction is from the groundwater to the streams and rivers. As the water tables have fallen, the flow direction has reversed, with water from the rivers and streams recharging the groundwater.

Jackson County and each municipality within the county have adopted a storm water plan that addresses the capabilities and requirements of the various storm water systems. In February 2003, Jackson County submitted a Phase II Storm Water Program to the USEPA that addressed the following issues: a) General non-point source pollution; b) Raw sewage; c) Solid waste dumping; d) Illegal disposal of wastes; e) Lack of erosion and sediment controls; and f) Impaired water bodies and total maximum daily loads (TMDL) programs.

The Storm Water Program includes procedures to provide public education, public involvement, illicit discharges detection and elimination, construction site runoff controls, post-construction runoff controls, and pollution prevention/good housekeeping.

The State of Mississippi regulates three categories of non-hazardous solid waste landfills: Municipal Solid Waste Landfills that receive household waste and other types of Subtitle D material, such as commercial and industrial solid waste and non-hazardous sludge; Class I Rubbish Sites that accept construction and demolition debris, brick, concrete, asphalt, natural vegetation, furniture, sawdust and wood shavings, plastic, and metal; and Class II Rubbish Sites that accept natural vegetation, brick, concrete, and asphalt (USACE, Mobile District 2000). Permitting for a solid waste facility is handled by the MDEQ Permitting Board.

There is one permitted municipal solid waste landfill in the Three-County Region and seven Class I rubbish sites for construction-related waste. The Pecan Grove Landfill and Recycling Center, operated by Waste Management, Inc., receives approximately 90 percent of the total solid waste stream produced in the three coastal counties. The landfill is located in Pass Christian.

2.13.3 Public Safety

Fire protection, emergency, and law enforcement services in Pascagoula (Jackson County) and the surrounding counties, Harrison, George, and Mobile, are summarized below.

2.13.3.1 Jackson County

Jackson County has 10 fire departments, including the Pascagoula Fire Department (Jackson County Fire District 2016). The Jackson County Sheriff's Department has two facilities: the main office in Pascagoula and a substation in Ocean Springs (Jackson County 2016).

The Pascagoula Fire Department has 58 full-time employees and has three frontline units, two standby units, one aerial 50-foot ladder truck, one rescue truck, and one standby rescue unit (City of Pascagoula 2016). The Pascagoula Police Department has 107 employees, including 57 sworn officers. The department has four Patrol Divisions, a Criminal Investigation Division, a Court Division, a Street and School Patrol Division, a Traffic Division, an Identification Division, an Administration Division, a Training Division, and a Public Relations Division (City of Pascagoula 2016).

2.13.3.2 Harrison County

The Harrison County Fire Service protects the Cities of D'Iberville, Biloxi, Gulfport, Long Beach, and Pass Christian from Hancock County to Jackson County, and up to Stone County, a total area of approximately 408 square miles with a population of 43,931. The Harrison County Fire Service employs 8 full-time paid fire personnel, 1 clerical person, 6 part-time paid personnel, and 140 volunteers (Harrison County 2016). Harrison County has nine fire departments, including the Biloxi Fire Department and Gulfport Fire Department (Firedepartments.net 2016). The Harrison County Sheriff's Department has various divisions, including Aviation, Chaplain, Criminal Investigation, Communications, Community Relations, Criminal Records, Operations, Adult Detention Facility, Marine Patrol, Motor Carrier, and Professional Standards and Reserves (Harrison County Sheriff's Department 2016).

Biloxi is located approximately 21 miles west of Pascagoula. The Biloxi Fire Department has 9 fire stations and employs 180 line firefighters and staff members. The department has nine engine companies, three ladder companies, three tankers, two command vehicles, one heavy rescue vehicle, one fire boat, one air/light vehicle, one support service vehicle, two reserve engines, one fire

investigations unit, and numerous staff vehicles. The department protects more than 50,000 residents in an area of about 61 square miles (City of Biloxi 2016). The Biloxi Police Department, as of November 2006, employed 132 sworn officers and had more than 200 vehicles. The Lopez-Quave Public Safety Center, located in East Biloxi, houses the police, fire, and municipal court personnel. The Public Safety Communications Center, located in North Biloxi, houses the City's 911 emergency dispatchers (City of Biloxi 2016).

Gulfport is located approximately 34 miles west of Pascagoula. The Gulfport Fire Department has 12 fire stations and employs 174 fire protection and rescue service workers. The department responds to a variety of calls, such as structure fires, aircraft emergencies, hazardous material spills, emergency medical calls, and marine emergencies (Gulfport Fire Department 2016). The Gulfport Police Department employs 293 personnel, 201 of whom are sworn personnel, and serves a population of 144,000 (Gulfport Police Department 2016).

2.13.3.3 George County

The George County Fire Service has 4 fire stations serving the 478 square mile area of the County (Firedepartments.net 2011; U.S. Census Bureau 2016). The George County Sheriff's Department has two locations, Lucedale and McLain (USM 2016).

Lucedale, the largest city in George County, is located 42 miles north of Pascagoula. The Lucedale Fire Department includes one fire station and three career firefighters (Firedepartments.net 2016). The Lucedale Police Department has 12 police officers and 6 other employees (City-data.com 2016).

2.13.3.4 Mobile County

The Mobile County Fire Service has 15 fire stations serving the 1,200 square mile area of the County (Firedepartments.net 2011; Mobile County Commission 2016). The Mobile County Sheriff's Office employs over 500 staff and operates the Mobile Metro Jail, which has a designed capacity of 816 (Mobile County Sheriff's Office 2016).

The City of Mobile is located approximately 40 miles northeast of Pascagoula. The City of Mobile Fire and Rescue Department has 20 fire stations, which includes 2 airports, and employs approximately 509 firefighters and fire-medics to serve a population of almost 250,000 in a 210 square mile area. The department has 18 fire engines, 5 ladder trucks, 9 rescue/ambulances, 1 hazardous material response unit, and 1 technical rescue response unit (City of Mobile Fire and Rescue Department 2016). The City of Mobile Police Department has 5 main precinct locations and 3 mini-precincts, and employs 522 authorized officers and 287 civilians (City of Mobile Police Department 2011; Mobile Police Department 2016). In 2016, the First Precinct through Fourth Precinct served a population of more than 250,000 (Mobile Police Department 2016).

2.13.4 Navigation and Ports

2.13.4.1 Port of Pascagoula

The Port of Pascagoula is the oldest industrial port on the Mississippi Gulf Coast, established by the Mississippi State Legislature in 1956. Port operations and development are managed by the JCPA. The JCPA is also responsible for management of the waterways leading into the two harbors that comprise the Port of Pascagoula, including traffic control, channel maintenance coordination, and enforcement of port tariff regulations.

The Port owns and operates public cargo facilities at its two harbors: Pascagoula River Harbor and Bayou Casotte Harbor. The Port has nine deepwater berths (4,820 feet) and one barge berth (695

feet). The Pascagoula River Harbor has five of the deepwater berths, 500 to 732 feet in length in 38 feet of water, 436,000 square feet of covered storage area, and 2,030,000 square feet of cold storage/freezer area. An additional 50 acres of land is available for open storage. Bayou Casotte Harbor has the other four deepwater berths, 516 to 737 feet in length in 38 feet of water, a barge berth in 15 feet of water, 350,000 square feet of covered storage area, 50,000 square feet of paved open storage area, and 10 acres of unpaved open storage area. The Port is public, though most facilities are operated through leases, operating agreements, or space assignment agreements with private operators or users (JCPA, 2016).

Typical export cargo includes forest/paper products, frozen foods, general cargo, project cargo, bulk and bagged grains, machinery, vehicles, fertilizer, petroleum products, petroleum coke, and petro-chemicals (JCPA, 2016). In 1999, exports were valued at $332.16 million (Couvillion and Allen, 2001). Import cargo includes general cargo, chemicals, forest products, bulk fish, rubber, and crude oil (JCPA, 2016). Imports were valued at $1,689 million in 1999 (Couvillion and Allen, 2001). Major tenants include Huntington Ingalls Ship Building Division, Chevron, Mississippi Phosphates Corporation, First Chemical Corporation, and VT Halter (JCPA, 2016).

Currently, Port facilities are 100 percent operational following damage from Hurricane Katrina in 2005. By mid-September 2006 cargo transportation and vessel calls were at 90 percent of historical levels. The JCPA sustained approximately $15 million in damage from 135-mile-per-hour winds and a 14- to 16-foot tidal surge associated with that storm (Port of Pascagoula, 2006).

2.13.4.2 Transportation

Although there are some smaller airports throughout coastal Mississippi, the Gulfport-Biloxi International Airport is the only passenger airport accepting major commercial airlines. Trent Lott International Airport is a county-owned public-use airport located six miles north of Pascagoula. Trent Lott International Airport is used for charter companies, flight training, and accommodates flight testing facilities for manned and unmanned airplanes and helicopters. Additionally, the airport is used by corporate clients including Northrop Grumman, Chevron, Omega Protein, and ERA Helicopters.

The Mississippi Gulf Coast is served by four (4) railroads including two Class I railroads. These railroads are CSX Transportation Railroad, Kansas City Southern (KCS) Railroad, Port Bienville Shortline Railroad and Mississippi Export 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 94-mile CSX track has an east-west orientation and serves as a major connection between the deepwater ports in New Orleans and Mobile. KCS Railroad is the second Class I railroad serving the Gulfport area. Its main line has a north-south orientation extending approximately 69 miles northward from the Port of Gulfport through Harrison, Stone, and Forrest Counties. 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 southwest of Waveland. The Mississippi Export Railroad is a Class III 42-mile short line railroad extending from Pascagoula to Evanston, Mississippi. It is the north-south corridor connecting the Canadian National Railroad and the east-west line of CSX Transportation. Rail service to the Port of Pascagoula is provided by CSX Transportation and Mississippi Export Railroad.

The area's overland infrastructure includes U.S. Highway 90 that is an east to west highway located approximately 3.5 miles north of the proposed site. The proposed site is accessed from U.S. Highway 90 via Highway 611. Located several miles north of U.S. Highway 90 is Interstate Highway 10. Access to the site from Interstate 10 is via Highway 63 that turns into Highway 611. The proposed site can also be accessed via Bayou Casotte waters.

2.13.4.3 Private Port Facilities

Several private industries operate shipping facilities and share the harbors with the Port of Pascagoula. Private industries in Bayou Casotte Harbor include Chevron Pascagoula Refinery, Mississippi Phosphates Corp., First Chemical Corp., VT Halter Marine, and Gulf LNG. The Pascagoula River Harbor is shared with Huntington Ingalls Ship Building Division, NOAA, the USCG, and the site of the former Naval Station Pascagoula. The FERC has approved recent permits for LNG facilities at Bayou Casotte Harbor in the past few years (JCPA, 2011).

The Chevron Pascagoula Refinery operates a marine terminal for crude oil marine tankers. The refinery imports crude oil, mostly from Central and South America. All of the crude oil processed at the refinery, over 100 million barrels a year, arrives by marine tanker. The marine terminal also has seven berths to load refined products. About 70 percent of all refinery products leave the refinery via ship or barge (Chevron, 2016).

VT Halter Marine operates three facilities for constructing small to medium-sized ocean-going vessels up to 50,000 deadweight tons (VT Halter Marine, 2016). The facilities are located in Pascagoula (Bayou Casotte), Moss Point, and Escatawpa.

Huntington Ingalls Ship Building Division includes 789-acre facility on the Pascagoula River. The facility has a floating drydock with a depth of 41 feet over the keel blocks, a lifting capacity of 38,000 tons, and capacity to handle vessels up to 820 feet long and 170 feet wide. The facility has produced luxury cruise liners, general cargo vessels, containerships, tankers, amphibious assault ships, cruisers, destroyers, submarine tenders, ammunition ships, and nuclear submarines (Huntington Ingalls, 2011).

The NOAA operates a NMFS laboratory and its Office of Marine and Aviation Operations in Pascagoula. Two NOAA research vessels are stationed there: the Oregon II and the Gordon Gunter (NOAA, 2016).

Naval Station Pascagoula was a base of the U.S. Navy, in Pascagoula, Mississippi. The base officially closed November 15, 2006. The base's property, on SRI in the Mississippi Sound at the mouth of the Pascagoula River, was formally transferred to the Mississippi Secretary of State's office July 9, 2007. The site occupies 187 acres of SRI. Waterfront support infrastructure includes a 680-foot double deck pier and two quayside berths.

2.13.4.4 Navigation Channel

Access to port and marine facilities is provided via a federally maintained navigation channel. Dimensions of the authorized and existing Federal navigation project have been previously described.

2.13.5 Population

Jackson County is located at the southeastern portion of the State of Mississippi. The county includes approximately 725 square miles in land and water area. Table 2.13.5-1 provides population data for the U.S., Mississippi, and Jackson County over the last 20 years for which data is available. An estimated 140,000 residents lived in Jackson County in 2016. This represents a population increase of 1.1 percent since 2010 and an increase of 7.4 percent since 2000.

Table 2.13.5-1
U.S. Census Bureau Statistics for Population Changes.

Area	Percent Change '10-'16	2000	2010	2016
United States	4.7%	281,421,906	308,745,105	323,127,513
Mississippi	0.7 %	2,844,658	2,968,103	2,988,726
Jackson County	1.1 %	131,420	139,668	141,241

*Source: U.S. Census Bureau

In 2016, approximately 70 percent of the population for Jackson County was 16 and over with 58.9 percent of the population in the labor force. The unemployment rate for the County was 9.7 percent, higher than both the State of Mississippi at 9.6 percent, and the U.S. at 8.3 percent. Table 2.13.5-2 lists occupational data for the study area.

Table 2.13.5-2
U.S. Census Bureau for Civilian Labor Force by Occupation for Jackson County, Mississippi, and the U.S.

	Jackson County	Mississippi	U.S.
Civilian employed population 16 years and over	56,399	1,216,050	143,195,793
Occupation			
Management, professional, and related occupations	17,594	361,465	49,473,347
Service occupations	11,394	210,415	24,036,006
Sales and office occupations	13,670	296,064	36,707,528
Farming, fishing, and forestry occupations	946	34,822	997,082
Construction, extraction, maintenance and repair occupations	8,625	146,996	13,804,087
Production, transportation, and material moving occupations	8,116	201,110	18,177,743

In 2016, the median household income of Jackson County was $48,406, higher than the State average but lower than the national average. The mean household income was $60,906. Table 2.13.5-3 shows the number of households in Jackson County, Mississippi, and the United States and the percentage of each by their respective household incomes.

Table 2.13.5-3: ***U.S. Census Bureau for Family Income for Jackson County, MS, and U.S.***

	Jackson County	Mississippi	United States
Total Households	48,406	1,081,052	112,386,298
Less than $10,000	8.6%	11.6%	7.2%
$10,000 to $14,999	5.6%	8.4%	5.5%
$15,000 to $24,999	10.8%	14.6%	10.6%
$25,000 to $34,999	11.7%	12.1%	10.6%

$35,000 to $49,999	14.7%	14.5%	14.2%
$50,000 to $74,999	21.6%	16.9%	18.8%
$75,000 to $99,999	11.9%	9.8%	12.5%
$100,000 to $149,999	10.1%	8.0%	12.2%
$150,000 to $199,999	3.0%	2.2%	4.3%
$200,000 or more	1.9%	1.8%	4.2%

Source: U.S. Census Bureau

2.13.6 Environmental Justice

On February 11, 1994, President Clinton issued EO 12898, *Federal Actions to Address Environmental Justice in Minority and Low-Income Populations* (Exec. Order No. 12898, Fed. Reg. Vol. 59 No. 32, February 11, 1994). The EO is designed to focus attention of Federal agencies on the human health and environmental conditions in minority communities and low-income communities. An Environmental Justice analysis performed to identify potential disproportionately high and adverse impacts to these communities and to identify alternatives that might mitigate these impacts. EO 12898 requires that Federal agencies conduct their programs, policies, and activities that substantially affect human health or the environment in a manner that ensures that such programs, policies, and activities do not have the effect of excluding persons (including populations) from participation in, denying persons (including populations) the benefits of, or subjecting persons (including populations) to discrimination under such programs, policies, and activities because of their race, color, or national origin.

On February 11, 1994, the President also issued a memorandum for heads of all departments and agencies, directing that USEPA, whenever reviewing environmental effects of proposed actions pursuant to its authority under Section 309 of the CAA, ensure that the involved agency has fully analyzed environmental laws, regulations, and policies.

Data from the U.S Department of Commerce, Census of Population and Housing were used for the Environmental Justice analysis. The population in 2016 for Mississippi was 2,988,726. Minority populations included in the census are identified as African American, American Indian and Alaska Native, Asian, Native Hawaiian and other Pacific Islander, Hispanic, of two or more races, and other.

The 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. From 2010-2016, approximately 21.2 percent of the residents in Mississippi were classified as living in poverty, higher than the poverty rate for the U.S. as a whole which was 13.8 percent (U.S. Census Bureau, http://quickfacts.census.gov/qfd/states/28000.html). In 2016, Mississippi ranked number one out of the 50 states for individuals living below the poverty level in the past 12 months.

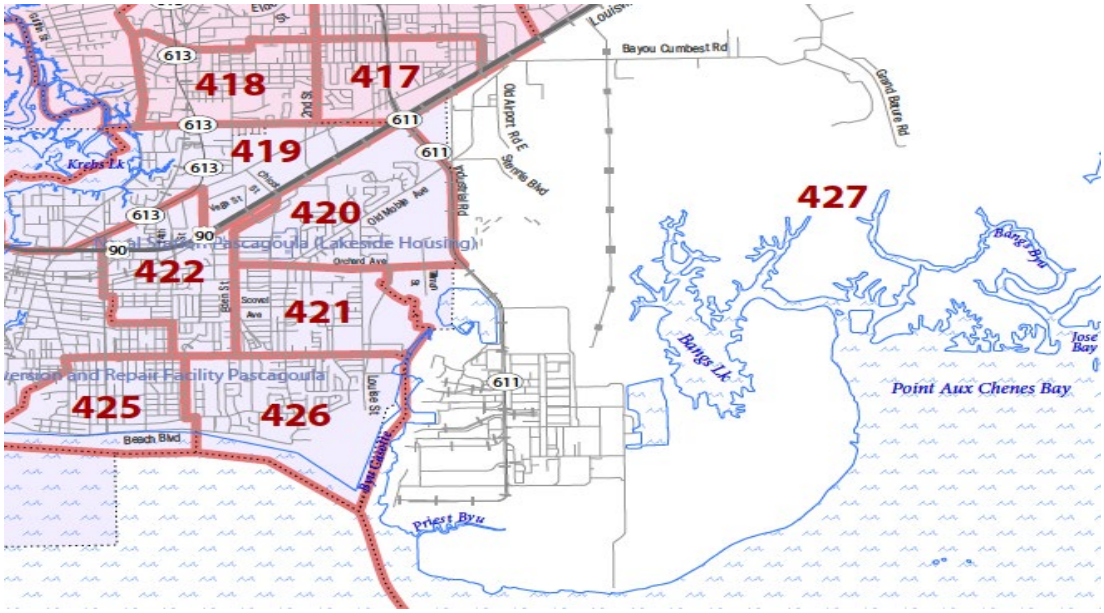
An estimated 140,000 residents lived in Jackson County in 2016. This represents a population increase of 1.1 percent since 2010 and an increase of 7.4 percent since 2000. The residents of Jackson County are racially and ethnically diverse. Based on 2016 census estimates, 21.9 percent of Jackson County residents are black, and 4.3 percent are Asian/Pacific Islander or Other. In the state of Mississippi, 37.7 percent of the population is black, while Asian/Pacific Islanders or other races amounted to 3.0 percent. Table 2.13.6-1 displays demographic for the Nation, State, and Jackson County.

Table 2.13.6-1
U.S. Census Bureau for Population By Race for Jackson County, Mississippi, and the U.S.

	Jackson County	Mississippi	U.S.
Total	141,541	2,988,726	323,127,513
White alone	73.3%	59.3%	76.9%
African American alone	21.9%	37.7%	13.3%
American Indian and Alaska Native alone	0.4%	0.6%	1.3%
Asian alone	2.3%	1.1%	5.7%
Native Hawaiian/Other Pacific Islander	0.1%	0.1%	0.2%
Two or more races	1.9%	1.2%	2.6%
Hispanic or Latino	6.2%	3.1%	17.8%
White alone, not Hispanic or Latino	68.0%	56.9%	61.3%

Source: U.S. Census Bureau

Figure 2.13.6-1
US Census Tracts, Pascagoula, MS 2016



As of 2016, the population in Mississippi was 2,988,726 – of this 141,541 individuals live in Jackson County. The Region of Influence for Environmental Justice is considered the census tracts and block groups immediately adjacent to the Bayou Casotte Federal Channel. The Bayou Casotte Federal Channel is located within Census Tract 427 and the adjacent census tracts include 420, 421, and 426 (Figure 2.13.6-1). Table 2.13.6-2 shows the 2016 race and ethnicity data for these census tracts, as well as corresponding data for the City of Pascagoula, Jackson County, and the State of Mississippi for comparison.

Table 2.13.6-2
Race and Ethnicity Data for the Region of Influence and Other Areas

	Block Group 2, Census Tract 427	Block Group 4, Census Tract 420	Block Group 1, Census Tract 421	Block Group 4, Census Tract 421	Block Group 1, Census Tract 426	Pascagoula, Mississippi	Jackson County, Mississippi	Mississippi
White alone	321	196	408	685	1,028	13,169	100,735	1,754,684
Black or African American alone	20	437	420	263	140	7,317	30,034	1,098,385
American Indian and Alaska Native alone	2	1	3	0	0	69	565	15,030
Asian alone	0	10	2	9	24	224	3,023	25,742
Native Hawaiian and Other Pacific Islander alone	0	0	0	4	0	14	79	1,187
Some other race alone	11	78	100	27	32	1,218	2,610	38,162
Two or more races	1	9	10	32	10	381	2,622	34,107
Total Population	355	731	943	1020	1,234	22,392	139,668	2,967,297
Hispanic[a]	30	143	189	122	62	2,472	6,378	81,481
Minority Population (percent)	9.6	73.2	56.7	29.	16.7	41.2	27.9	40.9
Hispanic Population (percent)	8.5	19.6	20	11.9	5.0	11.1	4.6	2.7

Source: U.S Census Bureau

[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.

The adjacent census tracts/block groups have low minority populations with the exception of Census Tract 420 Block Group 4 and Census Tract 421 Block Group 1, which have 73.2 percent and 56.7 percent, respectively. These block groups have a higher percentages of minority populations compared to the City of Pascagoula (41.2 percent), Jackson County (27.9 percent), and the State of Mississippi (40.9 percent). Similarly, Census Tract 420 Block Group 4 has a Hispanic population of 19.6 percent, which is higher than the City of Pascagoula (11.1 percent), Jackson County (4.6 percent), and the State of Mississippi (2.7 percent).

Table 2.13.6-3 identifies poverty levels within the Region of Influence. Three of the four adjacent census tracts (427, 420, and 421) have poverty levels that are near or above the City of Pascagoula average (21.6 percent) and the State of Mississippi average (20.4 percent). The average poverty level for Census Tract 426 (2.5 percent), however, is well below the Jackson County average (14.3 percent).

Table 2.13.6-3 *Poverty Levels for the Region of Influence for 2010*

	Census Tract 427	Census Tract 420	Census Tract 421	Census Tract 426	Pascagoula, Mississippi	Jackson County, Mississippi	Mississippi
<5 years	14	223	62	0	636	2,511	70,975
5 years	22	42	35	0	92	288	12,511
6 to 11 years	0	135	85	0	593	2,284	72,582
12 to 17 years	16	94	117	14	663	2,323	69,627
18 to 64 years	1	597	439	51	2,595	11,045	325,992
65 to 74 years	16	12	44	0	195	966	25,992
75 years and older	19	0	11	0	72	578	26,593
Subtotal:	88	1,103	793	65	4,846	19,995	604,272
Income below poverty level							
Total in Census Tract	1,016	4,808	3,213	2,596	22,392	139,668	2,967,297
Percent of population below poverty level	21.5	22.9	24.7	2.5	21.6	14.3	20.4

Source: U.S. Census Bureau, Census 2006-2010 American Community Survey

2.13.7 Protection of Children

On April 21, 1997, President Clinton issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks* (Exec. Order No. 13045, Fed. Reg. Vol. 62 No. 78, April 23, 1997). This EO 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. These risks arise because:

- Children's neurological, immunological, digestive, and other bodily systems are still developing.
- Children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults.
- Children's size and weight might diminish their protection from standard safety features.
- Children's behavior patterns make them more susceptible to accidents because they are less able to protect themselves.

Therefore, to the extent permitted by law and appropriate, and consistent with each agency's mission, the President directed each Federal agency to:

- Make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children.
- Ensure that the agency's policies, programs, and standards address disproportionate health risks to children that result from environmental health risks or safety risks.

Overall, the percentage of children in Block Group 4, Census Tract 420, and Block Group 1, Census Tract 421 is slightly above the 25.9 percent average for the City of Pascagoula, Jackson County, and the State of Mississippi. The remaining Block Groups in the Census Tracts adjacent to the Bayou Casotte Federal Channel are near or slightly below than the City, County, and State levels (Table 2.13.7-1).

Table 2.13.7-1: *Children 18 Years and Younger in Project Study Area*

	Block Group 2, Census Tract 427	Block Group 4, Census Tract 420	Block Group 1, Census Tract 421	Block Group 4, Census Tract 421	Block Group 1, Census Tract 426	Pascagoula Mississippi	Jackson County, Mississippi	Mississippi
Total Children under 18	83	242	285	262	307	5,790	35,600	755,555
Total Census Tract Population	355	731	943	1020	1,234	22,392	139,668	2,967,297
Percent Children	23.4	33.1	30.2	25.7	24.9	25.9	25.5	25.5

Source: U.S. Census Bureau, Census 2006-2010 American Community Survey

Examples of risks to children include increased traffic volumes and industrial or production-oriented activities that would generate substances or pollutants children might ingest or otherwise contact. Based on totals shown above, there are no disproportionately large populations of children living near the Bayou Casotte Federal Channel.

2.13.8 Socioeconomic Resources

The geographic area of the region of influence was determined by the physical location of the project study area, where the predominant social and economic impacts of the Proposed Action would be likely to occur.

2.13.8.1 Regional Economic Activity Development Analysis

The Gulf of Mexico is a major socioeconomic asset in terms of fisheries, tourism, agriculture, oil, infrastructure, trade, and shipping. The Gulf region contains one-fourth of the nation's seafood processing and wholesale establishments and provides jobs and recreational activities such as sport-fishing. In 2009, according to the NMFS, the commercial fish and shellfish harvest from the 5 U.S. Gulf states was estimated to be 1.42 billion pounds. In the same year, commercial catches in the Gulf were valued at over $629 million (NMFS, 2011).

In addition, economic conditions and trends in the Gulf coast region are closely associated with land and water 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).

Annual sales volumes for marinas approximate $22 million in Mississippi (Lynch et al., 2003). The Mississippi Sound area includes numerous public access marinas. The Gulf accounts for 30 percent of the U.S. offshore oil production and approximately 23 percent of the U.S. gasoline production. The infrastructure for oil and gas production in the Gulf area is concentrated in coastal Louisiana and east Texas. Approximately 55,000 workers are employed in the Gulf petroleum-related offshore industry.

The Regional Economic Development (RED) account measures changes in the distribution of regional economic activity that would result from each alternative plan. Evaluations of regional effects are measured using nationally consistent projection of income, employment, output and population.

The USACE Online Regional Economic System (RECONS) is a system designed to provide estimates of regional, state, and national contributions of Federal spending associated with Civil Works and American Recovery and Reinvestment Act (ARRA) Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE Recreation, Navigation, and Formally Utilized Sites Remedial Action Program (FUSRAP). Contributions are measured in terms of economic output, jobs, earnings, and/or value added. The system was used to perform the following regional analysis for the Bayou Casotte Harbor Channel Improvement Project.

The USACE Institute for Water Resources, the Louis Berger Group and Michigan University developed the regional economic impact modeling tool called RECONS ("the Tool") to provide estimates of regional and national job creation and retention and other economic measures such as income, value added, and sales. This modeling tool automates calculations and generates estimates of jobs and other economic measures such as income and sales associated with USACE's ARRA spending and annual Civil Work program spending. This is done by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The Tool will be used as a means to document the performance of direct investment spending of the USACE as directed by the ARRA. The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE. The Tool has been developed in both a desktop and on-line version.

Results of the Economic Impact Analysis

This RED impact analysis was evaluated at three geographical levels: Local, State and National. The local represents the Pascagoula impact area which encompasses the area included in an approximate 40-mile radius around the project area. The State level will include the State of Mississippi. The National level will include the 48 contiguous United States.

The following table displays the overall spending profile that makes up the dispersion of the total project construction cost among the major industry sectors. The spending profile also identifies the geographical capture rate, also called Local Purchase Coefficient (LPC) in RECONS, of the cost components. The geographic capture rate is the portion of USACE spending on industries (sales) captured by industries located within the impact area. In many cases, IMPLAN's trade flows Regional Purchase Coefficients (RPCs) are utilized as a proxy to estimate where the money flows for each of the receiving industry sectors of the cost components within each of the impact areas.

Table 2.13.8.1-1: Input Assumptions (Spending and LPCs)

Category	Spending (%)	Spending Amount	Local LPC (%)	State LPC (%)	National LPC (%)
Fuel	**20%**	**$5,957,400**	**83%**	**86%**	**89%**
Consumable Operating Expenses -- Textiles, Lubricants, and Metal Valves and Parts	**10%**	**$2,978,700**	**16%**	**24%**	**71%**

Consumable Operating Expenses -- Restaurants	**1%**	**$417,018**	**100%**	**100%**	**100%**
Repairs and Equipment	**40%**	**$11,914,800**	**95%**	**95%**	**100%**
Labor	**20%**	**$5,957,400**	**5%**	**5%**	**100%**
Consumable Operating Expenses -- Other Food and Beverages	**9%**	**$2,561,682**	**13%**	**24%**	**92%**
Total	**100%**	**$29,787,000**	**-**	**-**	**-**

Table 2.13.8.1-2 displays the geographical capture amounts for each of the three geographical impact analyses, which is that portion of spending that is captured in each impact area. It initially measures $17,762,361 at the local impact level and increases to $18,470,410 at the State level, and expands to a $28,055,394 capture at the national level. The labor income represents all forms of employment earnings. In IMPLAN's regional economic model, it is the sum of employee compensation and proprietor income. The Gross Regional Product (GRP) which is also known as value added, is equal to gross industry output (i.e., sales or gross revenues) less its intermediate inputs (i.e., the consumption of goods and services purchased from other U.S. industries or imported). The number of jobs equates to the labor income.

Table 2.13.8.1-2: Overall Summary Economic Impacts

Impact Areas / **Impacts**		**Regional**	**State**	**National**
Total Spending		$29,787,000	$29,787,000	$29,787,000
Direct Impact				
	Output	$17,762,361	$18,470,410	$28,055,394
	Job	124.50	130.16	286.17
	Labor Income	$8,265,117	$8,571,372	$15,426,684
	GRP	$10,450,788	$10,953,875	$18,488,444
Total Impact				
	Output	$23,197,590	$26,952,503	$69,798,648
	Job	165.50	202.87	532.11
	Labor Income	$9,766,573	$11,291,326	$28,838,015
	GRP	$13,527,797	$15,850,816	$42,143,669

The next three tables present the economic impacts by Industry Sector both for each geographical region. Impacts at the National level show a tremendous expansion most certainly due to the many multiple turnover of money that ripples throughout the national economy.

Table 2.13.8.1-3: *Economic Impacts at Regional Level*

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$4,881,187	0.60	$130,887	$577,452
198	Valve and fittings other than plumbing manufacturing	$2,426	0.01	$660	$1,185
319	Wholesale trade businesses	$166,660	1.18	$66,521	$127,180
323	Retail Stores - Building material and garden supply	$389,711	5.07	$174,836	$260,112
324	Retail Stores - Food and beverage	$255,237	4.77	$127,524	$185,898
332	Transport by air	$0	0.00	$0	$0
333	Transport by rail	$8,581	0.02	$2,857	$4,900
334	Transport by water	$1,616	0.00	$274	$668
335	Transport by truck	$40,165	0.30	$19,664	$22,881
337	Transport by pipeline	$1,493	0.00	$362	$348
413	Food services and drinking places	$417,018	7.98	$138,681	$210,409
417	Commercial and industrial machinery and equipment repair and maintenance	$11,300,397	98.07	$7,304,981	$8,761,885

5001	Labor	$297,870	6.49	$297,870	$297,870
69	All other food manufacturing	$0	0.00	$0	$0
	Total Direct Effects	$17,762,361	124.50	$8,265,117	$10,450,788
	Secondary Effects	$5,435,229	41.00	$1,501,456	$3,077,008
	Total Effects	**$23,197,590**	**165.50**	**$9,766,573**	**$13,527,797**

Table 2.13.8.1-4: Economic Impact at State Level

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$4,881,187	0.60	$130,887	$577,452
198	Valve and fittings other than plumbing manufacturing	$27,602	0.09	$7,513	$13,487
319	Wholesale trade businesses	$648,207	4.59	$277,697	$502,133
323	Retail Stores - Building material and garden supply	$417,334	5.43	$187,824	$278,906
324	Retail Stores - Food and beverage	$310,391	5.80	$155,582	$226,337
332	Transport by air	$144	0.00	$25	$43
333	Transport by rail	$9,985	0.02	$3,335	$5,708
334	Transport by water	$1,616	0.00	$274	$668
335	Transport by truck	$123,583	0.99	$60,505	$70,402
337	Transport by pipeline	$11,832	0.02	$2,870	$2,759
413	Food services and drinking places	$417,018	7.98	$138,681	$210,409
417	Commercial and industrial machinery and equipment	$11,300,397	98.07	$7,304,981	$8,761,885

	repair and maintenance				
5001	Labor	$297,870	6.49	$297,870	$297,870
69	All other food manufacturing	$23,244	0.06	$3,328	$5,815
	Total Direct Effects	$18,470,410	130.16	$8,571,372	$10,953,875
	Secondary Effects	$8,482,093	72.70	$2,719,953	$4,896,941
	Total Effects	**$26,952,503**	**202.87**	**$11,291,326**	**$15,850,816**

Table 2.13.8.1-5: Economic Impact at National Level

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$4,894,123	0.60	$131,409	$579,820
198	Valve and fittings other than plumbing manufacturing	$1,258,621	4.03	$342,599	$615,009
319	Wholesale trade businesses	$1,092,266	7.73	$472,434	$847,897
323	Retail Stores - Building material and garden supply	$417,334	5.43	$187,952	$279,090
324	Retail Stores - Food and beverage	$380,780	7.12	$191,392	$277,948
332	Transport by air	$2,539	0.01	$717	$1,254
333	Transport by rail	$16,688	0.04	$5,615	$9,567
334	Transport by water	$2,152	0.00	$384	$908
335	Transport by truck	$133,631	1.08	$65,425	$76,127
337	Transport by pipeline	$27,890	0.06	$12,014	$11,555
413	Food services and drinking places	$417,018	7.98	$138,681	$210,409
417	Commercial and industrial machinery and equipment repair and maintenance	$11,910,766	104.14	$7,699,545	$9,235,141
5001	Labor	$5,957,400	143.70	$5,957,400	$5,957,400

69	All other food manufacturing	$1,544,187	4.23	$221,118	$386,322
	Total Direct Effects	$28,055,394	286.17	$15,426,684	$18,488,444
	Secondary Effects	$41,743,254	245.95	$13,411,331	$23,655,225
	Total Effects	**$69,798,648**	**532.11**	**$28,838,015**	**$42,143,669**

Total Bayou Casotte Harbor Channel Improvement Project Economic Impact for the State of Mississippi geographical area as displayed in Table 2.13.8.1-4 is composed of $26,952,503 in sales, 202 jobs, $11,291,326 in labor income, and a contribution of $15,850,816 to GRP.

2.13.8.2 Pascagoula and the Port of Pascagoula

Pascagoula's employment sectors include manufacturing (20.7 percent), educational, health, and social services (17.2 percent), arts, entertainment, recreation, accommodation and food services (14.3 percent) and retail trade (11.6 percent) (City-data.com, 2011).

The Port of Pascagoula, operated by the JCPA, is the largest port in Mississippi and is centrally located on the Gulf of Mexico. The Port's transportation outlets, along with its proximity to deepwater shipping lanes, facilitate efficient cargo handling. The Port is public, though most facilities are operated through leases, operating agreements, or space assignment agreements with private operators or users. The Port includes two public terminal warehouses and four associated deepwater berths. Shipbuilding has been the primary industry in the area since the 1940s. Pascagoula is heavily dependent on the maritime industry and is also home of Mississippi's largest employer, Northrop Grumman (shipbuilder), which locally employs 10,358 people (Mississippi Business Journal, 2010). Typical export cargo ranges from forest/paper products to frozen foods to machinery and vehicles (JCPA, 2011).

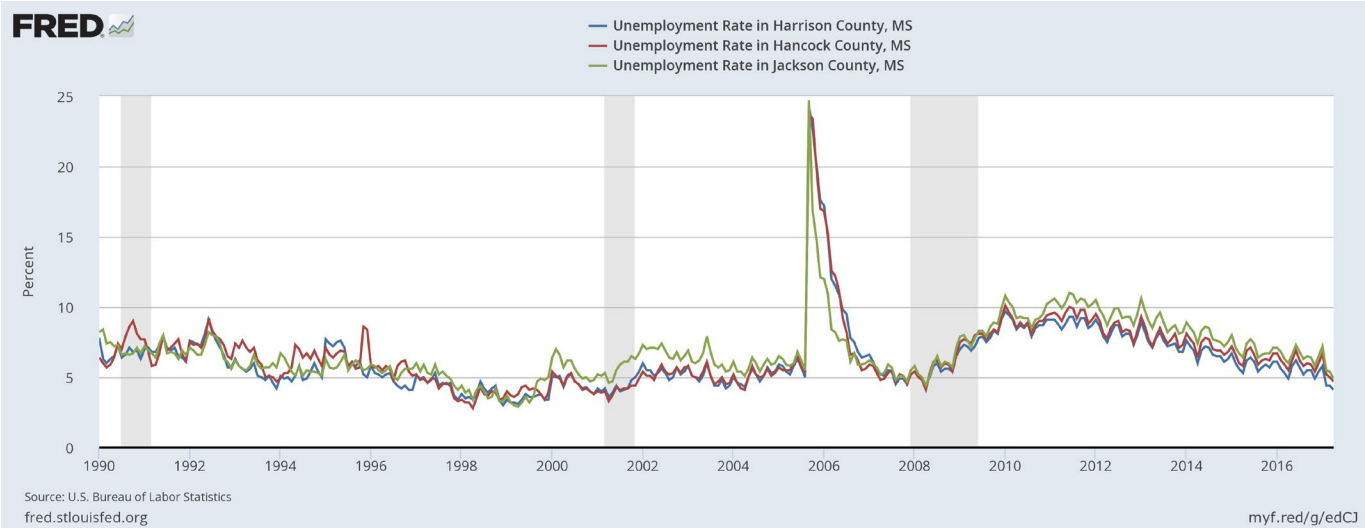
Several private companies and public entities operate in the harbor (see Section 4.12.7 for a complete list of these organizations). The Port of Pascagoula experienced a 2004 trade value of $4,624,000, including $764,000 in total exports and $3,878,000 in total imports. The Port of Pascagoula was ranked 35th in total trade value among all U.S. ports. Currently, the 10 largest employers for the City of Pascagoula include: Chevron Pascagoula Refinery, City of Pascagoula, Jackson County, Mississippi Power Company, Northrop Grumman Ship Systems, Pascagoula School District, Singing River Hospital System, Supervisor of Shipbuilding Conversion & Repair, and Wal-Mart (Jackson County Economic Development Foundation, 2011). The Port sustained severe damage during Hurricane Katrina in 2005, however, Port facilities have been rebuilt and the Port is currently functioning at 100 percent full capacity.

2.13.8.3 Port Facilities in the Region

Several private industries and public entities economically impact the Port of Pascagoula. The Pascagoula River Harbor is shared with Northrop Grumman Ship Systems, NOAA, the USCG, and the site of the former Naval Station Pascagoula. The Naval Station Pascagoula officially closed on November 15, 2006 and transitioned to the State of Mississippi for economic redevelopment. Chevron Pascagoula Refinery, Mississippi Phosphates Corp., First Chemical Corp., and VT Halter Marine are

private industries located in Bayou Casotte Harbor. The Biloxi economy is based on gaming and tourism, the seafood industry, and military and other Federal government installations, including Keesler Air Force Base (Keesler AFB) and the John C. Stennis Space Center. The Port of Gulfport is the primary economic engine for the City of Gulfport. Today, the Port contributes millions of dollars in annual sales and tax revenue to the State of Mississippi. The Port of Mobile supports more than 130 steamship lines with shipping capabilities for 376 inland dock facilities. More than 300 private firms, including 2 large ship repair businesses and numerous barge repair companies, support the Mobile maritime industry.

FIGURE 2.13.8.3-1: ***Unemployment Rates for Jackson, Harrison, and Hancock Counties, Mississippi between 1990 and 2016***



**Shaded areas indicate U.S. recessions*

2.13.8.4 Oil Spill Recovery in Mississippi

The Deepwater Horizon oil spill, which started April 20, 2010, discharged into the Gulf of Mexico through July 15, 2010. According to government estimates, the leak released between 100 and 200 million gallons of oil into the Gulf due to the Deepwater Horizon accident. The USCG estimates that more than 50 million gallons of oil have been removed from the Gulf, or roughly a quarter of the spill amount. Additional impacts to natural resources may be attributed to the 1.84 million gallons of dispersant that have been applied to the spill. Approximately 625 miles of Gulf Coast shoreline was oiled (approximately 360 miles in LA, 105 miles in MS, 66 miles in AL and 94 miles in FL) (July 29, 2010 Joint Information Center news release www.restorethegulf.gov). These numbers reflected a daily snapshot of shoreline that were experiencing impacts from oil; they do not include cumulative impacts to date, or shoreline that was already cleared.

3 MEASURES, ALTERNATIVES AND PROPOSED PLAN

3.1 Introduction

The Bayou Casotte Harbor Channel Improvement Project applied the six-step planning process described in the Economic and Environmental Principles and Guidelines (P&G) for Water and Related Land Resources Implementation Studies (P&G, 1983). This planning process is more fully specified in USACE's ER 1105-2-100 (the Planning Guidance Notebook, 22 April 2000).

As mentioned above, the Bayou Casotte Harbor Channel Improvement Project team (Civil Works) used the USACE planning process. This is compliant with the NEPA study process, which compares and contrasts measures and alternatives for a full range of anticipated impacts and effects. The USACE planning guidance requires that impacts and effects be evaluated in a "System of Accounts" framework. The four evaluation accounts were established by the P&G (1983) to facilitate evaluation and display of effects of alternative plans. Engineering Circular (EC) 1105-2-409, Planning in a Collaborative Environment (May 31, 2005) also reemphasized the use of the four accounts in conducting USACE's water resources feasibility studies as a means of ensuring that Federal water resources projects are planned and implemented in a collaborative manner with other Federal, state and local programs. Other information that is required by law or that will have a material bearing on the decision-making process has been included in the accounts to organize information on effects. Briefly, the categories of effect considered under each of the four accounts include the following:

(a) The National Economic Development (NED) account displays changes in the economic value of the national output of goods and services.

(b) The Environmental Quality (EQ) account displays non-monetary effects on significant natural and cultural resources.

(c) The RED account registers changes in the distribution of regional economic activity that result from each alternative plan. Evaluations of regional effects focus on plan induced changes in regional income, employment, output and population.

(d) The Other Social Effects (OSE) account registers plan effects from perspectives that are relevant to the planning process, but are not reflected in the other three accounts. Examples of effects categorized under the OSE account include: urban and community impacts; life, health, and safety factors; displacement; long-term productivity; and energy requirements and energy conservation.

3.2 Environmental Operating Procedures

The Mobile District is committed to implementing the USACE environmental operating principles in the assumption of maintenance for the Bayou Casotte Harbor Channel Improvement Project.

- Foster sustainability as a way of life throughout the organization.
  The project considered the sustainability of both the existing deep-water navigation project at Pascagoula and the natural resources within the area. The proposed channel widening would allow the port to serve its customers in a more cost effective manner by reducing the cost of transporting goods through the port while assuring the sustainability of area natural resources. The USACE considered the long term needs of the harbor for placement sites and found the existing sites to be adequate for the life of the project.

- Proactively consider environmental consequences of all USACE activities and act accordingly.
  The Project Delivery Team (PDT) worked closely with environmental agencies, both State and Federal, to review proposed project requirements and how those requirements will impact the environment and what can be done to minimize impacts.

- Create mutually supporting economic and environmentally sustainable solutions.
  The project has been designed to allow sustainability for both mankind and the natural environments. Mitigation is not required as a result of implementation. Dredged material will be placed in disposal areas that are consistent with RSM operating principles and when appropriate used beneficially.

- Continue to meet our corporate responsibility and accountability under the law for activities undertaken by the USACE which may impact human and natural environments.
  The project will not impact human health and welfare in the project vicinity.

- Consider the environment in employing a risk management and systems approach throughout life cycles of projects and programs.
  The USACE considered cumulative impacts in its assessment of the ecological and social value of resources that the project would impact. The project features were designed recognizing the present and expected future status of environmental resources, how those resources function in the project area, and how those resources are influenced by man's activities.

- Leverage scientific, economic, and social knowledge to understand the environmental context and effects of USACE actions in a collaborative manner.
  The adoption of stakeholder input through various meetings assured that possible impacts from project widening were identified and evaluated.

- Employ an open, transparent process that respects views of individuals and groups interested in USACE activities.
  Inclusion of the general public, stakeholders, and others in the study process insured the identification of valuable concerns and suggestions that were considered during the planning process.

3.3 Accommodating Uncertainty in Future Sea Level Rise

Analysis of historical data suggests a relative sea level rise of approximately nine inches along the Mississippi coast during the 20th century. Relative sea level rise is what an observer standing on the shoreline over a long period would observe, which includes the combined effects of land subsidence (or uplift) and the rise of sea level in and of itself. For the last 25 years, the climate change community has also been arguing that sea level rise will accelerate in the 21st century, though to date, there is no clear confirmation that acceleration is actually taking place.

It is important to recognize that sea level has been rising, and it's prudent (and required by USACE regulations) to recognize the uncertainties inherent in sea-level rise projections. Given the long-term nature of this phenomenon, future sea level rise was projected over a 100-year period. However, the period of analysis specified by ER 1105-2-100 for USACE water resources projects of this type is 50-years. Based on extension of the Biloxi, MS tide gage data, predicted 21st century sea level rise is about 0.8 feet, about 0.4 feet over a period of 50 years. This assumes that sea level rise proceeds in the 21st century at a rate corresponding to the 20th century rate at this location. Assuming a high rate of rise in accordance with USACE guidance gives an estimate on the order of five feet of rise over the

21st century. More details are available on sea level rise analysis in the Engineering Appendix of the Main Report.

3.4 Regional Sediment Management Operating Principles

Sediment management benefits a region by potentially saving money, allowing use of natural processes to solve engineering problems, and improving the environment. As a management method, Regional Sediment Management (RSM):

- Includes the entire environment, from the watershed to the sea;
- Accounts for the effect of human activities on sediment erosion as well as its transport in streams, lakes, bays, and oceans;
- Protects and enhances the nation's natural resources while balancing national security and economic needs;
- Recognizes sediment as a valuable resource that is integral to the economic and environmental vitality of the Nation. Proactively evaluates the utilization of all sediment resources for implementing sound RSM practices;
- Strives to achieve balanced, sustainable solutions to sediment-related issues. Seeks opportunities to implement RSM plans, practices and procedures to improve sediment management and solve sediment issues;
- Coordinates and communicates with partners and stakeholders in the evaluation, formulation, and implementation of RSM plans, practices and procedures. Partners with stakeholders to balance objectives and leverage resources;
- Makes local project decisions in the context of the sediment system and considers the regional implications beyond the local site, beyond project-intended effects, and over longer time scales (decades or more). Evaluates the impacts of individual projects on adjacent projects and the regional system;
- Integrates a systems approach to the management of sediment from upland sources, through river systems, into estuaries, and along coastal regions. Applies RSM principles to the entire watershed and includes watershed impacts in the evaluation of coastal projects;
- Be responsible for our actions and for advancing RSM principles. Monitors implemented projects to evaluate the physical, environmental, and social impacts of our actions at the local and regional scale. Seeks opportunities to improve project efficiencies and minimizes negative impacts; and
- Applies technical knowledge, tools and uses available resources to understand the dynamics of local and regional systems prior to and following actions to improve the management of sediment.

The USACE holds in trust and manages lands and waterways across the U.S. Using RSM concepts can significantly improve the USACE’s mission accomplishment. The USACE's engineers and scientists develop new technologies through research to make management decisions more accurate and efficient. Simultaneously, they evaluate RSM concepts through projects that highlight and improve

sediment management activities. RSM concepts will be incorporated into the assumption of maintenance for the Bayou Casotte Harbor Channel Improvement Project.

3.5 Measures and Alternative Plans

In accordance with NEPA, (32 CFR § 1502.14) the alternatives section is the heart of the EIS, identifying the alternatives considered, explaining why certain options were eliminated from further consideration, and evaluating potential impacts to identify the environmentally preferred alternative (i.e. the tentatively selected alternative as referred to in the associated Civil Works' Feasibility Study). Based on the information and analyses presented in the Affected Environment and the Environmental Consequences sections (Sections 2 and 4, respectively), the environmental impacts of potential alternatives are compared, thus sharply defining the issues and providing a clear basis for choice among options by the decision-maker and the public. The alternatives analysis includes an evaluation of reasonable alternatives, including the No Action Alternative. Some alternatives are discussed and eliminated from detailed study; other alternatives are considered in detail in the EIS.

The general environmental criteria for navigation projects are identified in Federal environmental statutes, EOs, and planning guidelines. National policy requires fish and wildlife resource conservation be given equal consideration with other study purposes in the formulation and evaluation of alternatives. Thus, care was taken to preserve and protect significant ecological, cultural, and natural resources. In developing and considering alternatives, particular emphasis was placed on:

- Protection and preservation of the existing fish and wildlife resources, including estuaries, wetland habitats, and water quality, and improvement of these resources by the use of dredged material for beneficial use for creation and/or protection of habitat;

- Consideration in the project design of the least disruptive construction techniques and methods; and

- Preservation of significant historical and archaeological resources through avoidance of impacts.

In order to identify all possible arrays of alternatives, the study team first identified actions that were described as measures. Study measures are single features or activities that address a study's planning objectives. Plans (alternatives) are combinations of one or more measures. Measures included possible improvements to the navigation channel, such as dredging (i.e. 'structural') and managerial improvements to its existing operations (i.e. 'non-structural'). Should dredging be pursued, disposal sites would be needed to accommodate the dredged material for the new work and future O&M operations. An array of disposal measures was identified to accommodate potential dredged material associated with possible 'structural' improvements. Measures were then either eliminated from further detailed analysis or continued in various ways to form an alternative. These alternatives were individually evaluated based on economic, environmental, and engineering feasibility.

3.5.1 Study Improvement Measures

The preliminary list of planning measures identified for the Bayou Casotte Harbor Improvement Project is shown below. Both structural and non-structural measures were evaluated.

- No Action
- Channel Widening from Horn Island Pass to the mouth of Bayou Casotte
- Alternate Vessel Speeds

- Navigation Aids
- Tug Assist
- Harbor Control System
- Bend Easing

3.5.2 No Action

The USACE is required to consider the option of "No Action" as one of the measures in order to comply with the requirements of the NEPA. With the No Action Plan (i.e., the Without Project Condition), it is assumed that no project would be implemented by the Federal Government or by local interests to achieve the planning objectives. Under the No Action Plan, the non-Federal sponsor would not implement any improvements to the navigation channel at Lower Pascagoula and Bayou Casotte, and the Federal Government would continue its O&M of those channels to maintain authorized project dimensions of 42 feet deep (plus 2 feet of advanced maintenance and plus 2 feet of overdepth dredging) by 350 feet wide. The No Action Plan, therefore, forms the basis to which all other alternative plans are compared against.

3.5.3 Channel Widening Measures

The channel widening structural measure consists of numerous channel widening options for the Lower Pascagoula and Bayou Casotte legs of the deep draft navigation channel at the Port of Pascagoula. Widening of this navigation channel commences north of Horn Island Pass, continuing through Mississippi Sound, and concluding south of the mouth of Bayou Casotte Harbor.

Table 3.5.3-1 Channel Widening Measures

Structural Measure	Description
1	50-foot widening on West Side of Channel
2	100-foot widening on West Side of Channel
3	150-foot widening on West Side of Channel
4	50-foot widening on East Side of Channel
5	100-foot widening on East Side of Channel
6	150-foot widening on East Side of Channel
7	25-foot widening on Both Sides of Channel
8	50-foot widening on Both Sides of Channel
9	75-foot widening on Both Sides of Channel

Quantities of dredged material removed from the navigation channel vary depending upon the selected measure (Table 3.6.3). Projected amount of time needed for project construction varies by the selected alternative. Preliminary results of initial channel widening evaluation efforts will be described in more detail in document sections that follow.

3.5.4 Bend Easing Measures

During the planning process, it became apparent that bend easing between the Horn Island Pass and the Lower Pascagoula Channel would assist in vessel transition between those channel segments. Therefore, at the request of the JCPA, this structural feature was also evaluated.

Table 3.5.4-1 Project Alternatives

Alternative	Description
A	No Action, Without Project Condition
1	50-foot widening on West Side of Channel
2	100-foot widening on West Side of Channel
3	150-foot widening on West Side of Channel
4	50-foot widening on East Side of Channel
5	100-foot widening on East Side of Channel
6	150-foot widening on East Side of Channel
7	25-foot widening on Both Sides of Channel
8	50-foot widening on Both Sides of Channel
9	75-foot widening on Both Sides of Channel
10	50-foot widening on West Side of Channel w/Bend Easing
11	100-foot widening on West Side of Channel w/Bend Easing
12	150-foot widening on West Side of Channel w/Bend Easing
13	50-foot widening on East Side of Channel w/Bend Easing
14	100-foot widening on East Side of Channel w/Bend Easing
15	150-foot widening on East Side of Channel w/Bend Easing
16	25-foot widening on Both Sides of Channel w/Bend Easing
17	50-foot widening on Both Sides of Channel w/Bend Easing
18	75-foot widening on Both Sides of Channel w/Bend Easing

3.5.5 Vessel Speeds Measures

Alternate vessel speeds were considered for their ability to help reduce and/or eliminate any of the identified study problems. In particular, this non-structural measure was considered for its ability to reduce harbor congestion or increase vessel maneuverability during inclement weather. Based upon discussions with the pilots and facility representatives, it has been determined that vessel traffic is currently operated at optimal speeds required for vessel maneuverability given channel conditions and the nature of the cargo being carried. Therefore, this measure would not address the identified channel problems or project purpose and need and was eliminated from further consideration and environmental analysis.

3.5.6 Navigation Aids Measures

Aids to navigation are the markers and signals vessels required to safely utilize a navigation project (USACE, 2006). The navigation safety of a project is directly related to the clarity and visibility of aids to navigation. Channel design must be planned so that the layout, dimensions, and alignment facilitate clear marking. A reduced width may be possible in a well-marked channel as compared to a poorly marked channel, so a tradeoff between channel widening cost and aids to navigation cost has been considered in design. Clear marking of the navigation channel is another non-structural measure.

Beacons are fixed structures, generally on pilings in shallow water up to about the 15-foot depth. Buoys are floating, anchored to the bottom with a chain connected to a concrete block. They mark channel boundaries, hazards, and channel curves or turns, especially in areas where water depth makes beacons impractical. Height above the water, and hence visibility, is more limited for buoys

than for beacons. Another limitation of buoys is that their location relative to the channel is imprecise. It can vary over a small distance because buoys are free to move about the anchor point in response to environmental forces. Occasionally, buoy/anchor systems are completely moved out of position by strong environmental forces or by vessel impacts. Buoys are also susceptible to sinkage or drifting if mooring connections are lost.

Ranges are pairs of fixed structures usually aligned with the channel center line at one or both ends of straight reaches. They are usually on shore or in very shallow water. The rear marker is always higher than the front marker. They are typically marked with rectangular signs, designated by letters, high-intensity lights, and red and white vertical stripes. By observing the placement of front and rear markers relative to each other, mariners can determine vessel position relative to the channel centerline. Practical limitations on range marker height, visibility through fog, and earth curvature effect on line of sight dictate that straight channel reaches should be no longer than about 5 to 6 miles. Additional important aids to navigation along the seacoast include major lights and sea buoys. One or more major lights are located near each harbor entrance. The high-intensity, well-maintained lights are located on fixed structures or towers at heights of up to 200 feet, sufficient to be visible over a long distance. Electronic aids to navigation are often collocated with major lights. Sea buoys are large, easily visible buoys marking the ocean end of most deep-draft harbor entrance channels. A typical sea buoy is 40 feet in diameter and 30 feet or more in height, with high-intensity light, electronic aids, and a sound signal. Sea buoys are usually located in deep water on the channel centerline extended 1 to 2 miles seaward beyond the channel's seaward end. Often the sea buoy marks an area where inbound ships await local pilot assistance. It is good practice to use a variety of navigational aids to prevent a navigational crisis.

Navigation aids were considered for their ability to help reduce and/or eliminate the identified study problems. After meetings with harbor pilots and facility representatives, it was determined that this measure alone would not be sufficient to address existing and future issues in part due to the inclement weather impacts on existing channel features.

It should be noted, however, that additional navigation aids may be required with implementation of channel widening features, specifically those measures that would allow for nighttime transit of certain vessel types. If the USCG determines that channel modification requires installation of additional aids to navigation, inclusion of these aids would be the result of the USCG's responsibility to provide for channel markings and not as a result of an independent study measure. Therefore, this measure was eliminated from further consideration and environmental analysis. However, this may become a project feature that would be implemented by the USCG during construction, if required.

3.5.7 Tug Assist Measure

Additional tug assistance was considered for its potential to help increase vessel safety and/or reduce harbor congestion. Similar to the aforementioned study measures, tug assist was also evaluated as a complement to other study measures.

Tugs are currently used for turning and berthing some vessels that call on the harbor. After discussions with the harbor pilots, it was determined that tug assistance during channel transit for these harbor users would not address the operational inefficiencies occurring under existing or forecast future conditions. However, it should be noted that additional tug assistance may be required for those LNG vessels forecasted to call on the harbor under future conditions. If required, it is anticipated that this assistance would occur regardless of whether the channel is widened and not a separate measure to address identified problems for this harbor and therefore, this measure was eliminated from further analysis.

3.5.8 Harbor Control System Measure

Modification of the existing traffic management system utilized by the Port of Pascagoula was evaluated to determine whether modification or implementation of a new system would assist in reducing harbor congestion by increasing vessel operating efficiencies. It was determined that the traffic management system currently employed by the Port of Pascagoula and the Pascagoula Bar Pilots Association includes active scheduling and traffic management by the Port of Pascagoula Harbormaster, as well as ship to ship and ship to dispatch communication via radio/telephone as ships traverse the harbor. Each Pilot is in contact with the Harbormaster, dispatcher, other shipboard Pilots, and other (inland) marine traffic as they pilot vessels into and out of the harbor. Vessel scheduling is coordinated by the Harbormaster who takes into consideration traffic volumes, transit restrictions/limitations for particular vessels, allocation of tug/pilot assets, current and forecast weather conditions, and industry need.

The Port considers this the most cost-effective traffic management system for the Port at this point in time. Traffic scheduling and priorities are determined with input from channel users, local channel-dependent industry, and vessel service providers. The Port has evaluated a system managed by the USCG called the Vehicle Traffic Service, but this system, is expensive, and at this point in time would not provide a better management system than they already have. This non-structural measure would not address identified problems for this harbor and therefore was eliminated from further analysis.

3.5.9 Dredged Material Disposal Site(s) Measures

New work material would be generated in areas not previously dredged; maintenance material would be obtained from areas where dredging has occurred and sedimentation has affected the approved channel depths and/or widths. The new work and associated maintenance material from the channel would have different physical characteristics, with differing effects on the environment resulting from disposal activities. Once material has been removed from the channel, it must be managed, placed, or disposed of, in an approved manner - engineeringly feasible, economically justified, and environmentally acceptable. Beneficial Use consideration must be given to this sediment as a resource. Options for placement of new work and/or O&M material include:

- Placement in existing designated open-water sites;
- Placement in an existing designated ODMDS;
- Placement in designated and/or new upland confined placement areas; and
- Beneficial use of material and/or placement in beneficial use sites.

3.5.9.1 Open-water Disposal Site(s) Measure

Open-water disposal sites adjacent to the channel consist of sites 3 and 4 east of Bayou Casotte and 5, 6, 7, 8, and 9 west of Upper and Lower Pascagoula Channels. These sites have finite capacities due to the -4-foot depth restriction. Suitability testing of material disposed of at these sites is required for continued utilization and with the onset of the Deepwater Horizon Oil Spill some uncertainty exists for continued suitability of this material for open-water placement. Use of solely open-water sites for disposal of new work material dredged from the Lower Pascagoula and Bayou Casotte Leg channels' widening and subsequent O&M would not provide a holistic reliable disposal option. Compacted new work material stacks more than that of O&M material; therefore, it would likely fill sites above the -4-foot depth restriction due to the stackable nature of the material. O&M material typically consists of silts, clays, and some sands and is recently settled along the channels' bottom and side slopes. This material has not had sufficient time to consolidate. Furthermore, the amount of water associated with

removing the material alters its stacking in the water column. Hydraulic dredges typically used for O&M activities have greater water associated with dredged material being pumped through the pipeline while mechanical and/or hopper dredges typically have less water and are often used for new work operations. Future O&M open-water disposal use is a viable measure and consistent with RSM principles (by retaining this vital sediment within the system) when combined with other practicable measures; thus, was identified as a component of various alternatives proposed.

3.5.9.2 Ocean Disposal Site Measure

The USEPA, Region 4 designated the Pascagoula ODMDS in July 1991 for materials dredged from the Mississippi Sound area that meets the Ocean Dumping Criteria (40 CFR § 220-228). Pascagoula ODMDS is located within the area bounded by Horn Island to the north, the Pascagoula Ship channel to the east, the navigation safety fairway to the south, and a north-south line running through Dog Keys Pass to the west. The site covers an area of approximately 24.3 nautical square miles with depths varying from about 30 feet in the north to 60 feet in the south. The boundary coordinates of the Pascagoula ODMDS are (NAD 27):

30°12’06” N	88°44’30” W
30°11’42” N	88°33’24” W
30°08’30” N	88°37’00” W
30°08’18” N	88°41”54” W

The intended use for the Pascagoula ODMDS is maintenance and new work material from the Pascagoula Harbor Federal navigation project, for maintenance material from the channels and turning basin associated with the now closed Naval Station Pascagoula (formerly at the SRI site), and possibly by private entities, such as the JCPA, Northrop Grumman (formerly known as Ingalls Shipbuilding), and Chevron Refinery. Much of this use is projected to occur in the future and therefore the exact nature and quantity of the material, the time of disposal, and the type of equipment to be used are unknown. Physical and biological conditions at the ODMDS are described in the *Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site located Offshore Pascagoula, Mississippi* and updates are recorded in the Pascagoula ODMDS - Status and Trends, April 2006. (USEPA, Region 4, 2006) The Status and Trends sampling data indicated that while some significant differences were found when comparing the actively-used part of the site to that which had never been used, there were no discernible differences if the area dumped on was compared to areas outside the ODMDS. The Status and Trends concluded the data collected in April 2006 shows that the benthic community of the Pascagoula ODMDS is viable, healthy and showing no indication that any type of adverse impact has occurred due to the dumping of dredged material. Ocean disposal in the Pascagoula ODMDS is more costly than deposition in the upland or open-water disposal sites due to the longer hauling distances and dredged material suitability testing and site management requirements.

Reliance solely on the use of Pascagoula ODMDS is not feasible due to a number of factors. First, the northern portion of the Gulf of Mexico has a high concentration of natural gas that, if recovered, would provide the State of Mississippi with additional revenue. Competing uses, such as oil and gas recovery and recreational and commercial fishing, in the ocean site could alter future use. The eastern portion of the Pascagoula ODMDS site has historically been used to dispose of material dredged from the project’s channel. Eventually extensive use of this eastern area will result in additional hauling of material to the middle or western portions of the Pascagoula ODMDS for sufficient capacity. An extensive survey of the western portion of the Pascagoula ODMDS site would be needed prior to the disposal. This movement westward will increase the transporting costs to the ocean site. Also, with minimal USEPA budget, westward use would raise their site management costs. Another cost and uncertainty associated with ODMDS disposal is the dredged material suitability and testing costs.

Testing is required to receive the 3-year concurrence at an approximate cost of $550,000 per testing cycle. However, with the Deepwater Horizon Oil Spill events, it is uncertain if material will continue to meet Ocean Dumping Criteria and it is unlikely to reduce testing frequency in the foreseeable future. Furthermore, sole use of this disposal option for new work and maintenance is not consistent with the USACE's RSM principles. The RSM principles allows USACE to better manage sediment, potentially money saving while benefitting the overall region. It allows use of natural processes to solve engineering problems, and improves the environment by keeping sediment within the system. Using the RSM principles process results in improved communication between Federal, State, and local resource agencies and sharing of technologies.

The Pascagoula ODMDS designated for new work and O&M material does have capacity to accommodate both this new work and future O&M projected quantities. Placement of dredged material at the ODMDS is restricted to depths below –25 feet MLLW but this restriction would not be exceeded by the volume of material generated from proposed dredging, a maximum of approximately 5 million cys associated with proposed alternatives. The site is considered to be dispersive (i.e., the deposited material is dispersed during storms or strong current activity). With its dispersive nature, future O&M material could also be placed there, but placement of all of this material offshore would not be consistent with USACE's RSM principles. Evaluation oversight is provided by the USACE for the transport of dredged material under MPRSA Section 103, and the sediment evaluations and testing are subject to EPA review and concurrence. A combination of the Pascagoula ODMDS use for new work and some O&M dredged material was considered further in the considered alternatives.

3.5.9.3 Upland Disposal Sites Measure(s)

Triple Barrel Upland Disposal Site Measure

The upland Triple Barrel disposal site is located north of SRI on the west bank of the Pascagoula River just south of the L&N Railroad. Triple Barrel disposal site, encompassing about 92 acres, generally accommodates dredged material from the inland portion of Pascagoula River Harbor. Minimal vegetation occurs within the disposal site due to its continual use. Currently, extensive management of Triple Barrel is required to accommodate additional placement of dredged material.
Extensive expansion of Triple Barrel is limited by development and environmental constraints, such as the loss of pristine wetlands. In fact, detailed expansion was investigated during the Pascagoula River Harbor DMMP study to the north and west but was not supported by the resource agencies due to wetland issues. Heavy industrial development lies immediately east of Triple Barrel while pristine emergent wetlands are further to the west along the shoreline. Triple Barrel dikes have been raised to 32 feet National Geodetic Vertical Datum 88 as part of the 2010 Pascagoula River Harbor DMMP effort to accommodate material dredged from that portion of the Federal navigation channel. Capacity calculations did not account for quantities from the Bayou Casotte improvements plus the far pumping/hauling distance of the site is not cost-effective. This site is not a suitable disposal option for the Bayou Casotte improvements and subsequent O&M material because of its existing Pascagoula River Harbor designated use, limited capacity, and distance from the proposed dredging activities.

Bayou Casotte DMMS Measure

The Bayou Casotte DMMS is a 136-acre site located on the east bank of Bayou Casotte near its entry into Mississippi Sound. The Bayou Casotte DMMS was constructed for assumption of O&M material dredged from the Bayou Casotte Inner Harbor. The estimated total dredging requirements in Bayou Casotte Inner Harbor is 580,200 cys (in situ) every three years. This in situ quantity when disposed into the Bayou Casotte DMMS would increase to approximately 1,044,000 cys (580,200 cys x 1.8 bulking factor) due to the additional water introduced by the dredging process. Dredged material is placed into the Bayou Casotte DMMS in lifts of about four to five feet with a hydraulic pipeline dredge. The management process will remove excess water in order to reduce the total volume of space

required to contain the material and/or to dry the material for a beneficial use. Beneficial uses would include placement of material on the dikes as an integral part of site management or as a borrow source for a manufactured soil process. Use of this site for disposal of new work material is not a feasible option due to exceeding its designed capacity and project life. Some O&M material dredged from the navigation project could be placed within the Bayou Casotte DMMS upland facility.

Other Upland Disposal Sites in the Vicinity Measures

The USACE, Mobile District personnel from Planning and Environmental Division, Coastal Environmental Team (PD-EC) and Operations Division, Regulatory Team evaluated the following possible upland disposal sites: F-8, F-10, H-1, H-3, H-7, H-6, and H-4 during the Pascagoula River Harbor DMMP and other disposal efforts. These sites were initially assessed based upon acreage, wetland/upland characteristics, and location in relation to the project site. During this investigation, none of the sites were found to be suitable as possible disposal options due to development, size, and/or distance from the dredging project.

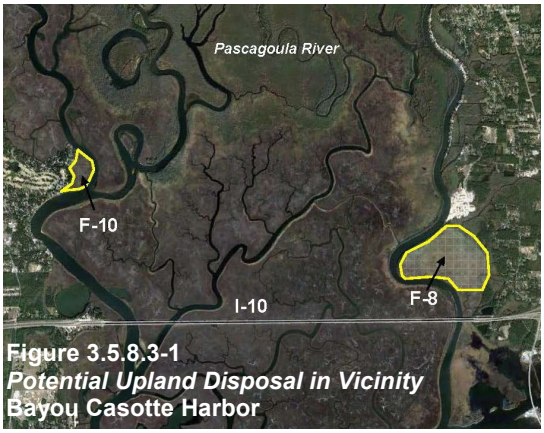


Figure 3.5.8.3-1
Potential Upland Disposal in Vicinity
Bayou Casotte Harbor

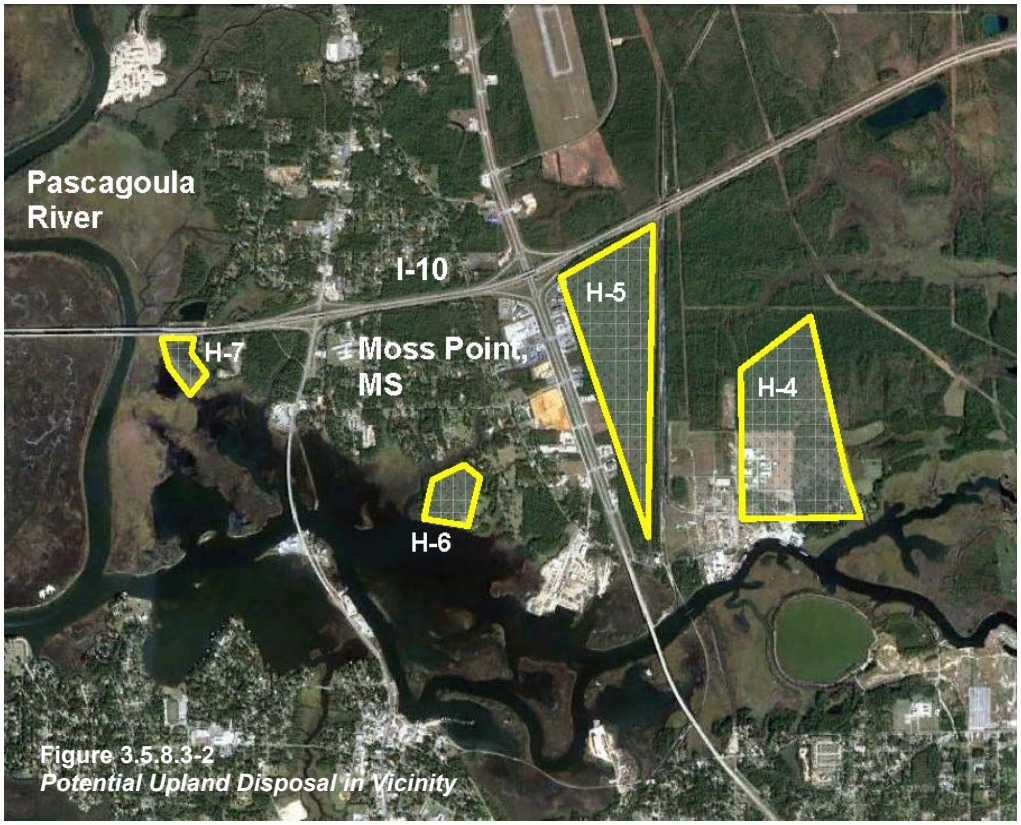
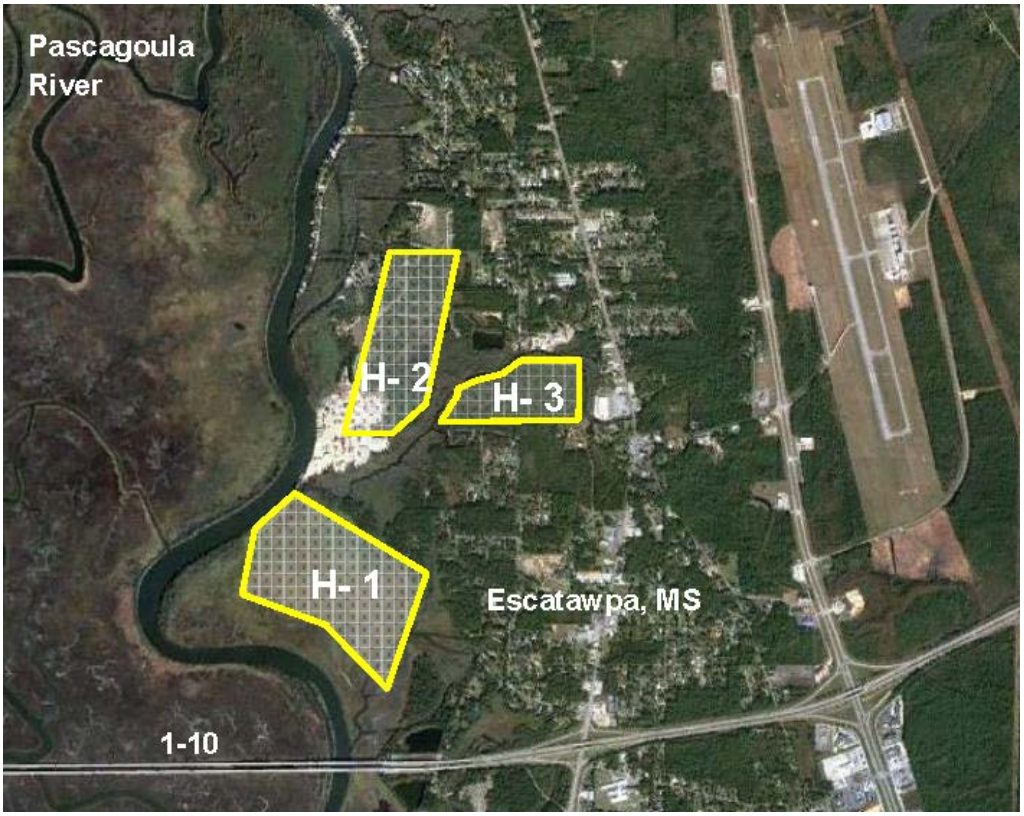


Figure 3.5.8.3-2
Potential Upland Disposal in Vicinity



3.5.9.4 Beneficial Use Measure(s)

Greenwood Island Semi-Confined Site Measure

In lieu of the 7.5 acre mitigation requirement outlined in the January 2000 report (*Dredged Material Management Plan for the Maintenance of Bayou Casotte Inner Harbor, Pascagoula Harbor, Mississippi*), the USACE, Mobile District constructed an 18-acre breakwater containment site, near the 6-acre mitigation site, located south of Greenwood Island, Jackson County, Mississippi in Mississippi Sound. The 18-acre site is one of the sites available to private applicants for placement of their dredged material, if found suitable, as part of the MDMR's general permit in order to create emergent tidal marsh habitat. The site has been used by several private entities and does not have adequate capacity to accommodate the estimate 3.4 million cys from the new work dredging project and subsequent O&M effort.

Singing River Island Semi-Confined Site Measure

A dredged material placement site has been constructed in open-water located east and south of the existing SRI, encompassing 425 acres and accommodating roughly 5.3 million cys of material. The 425-acre site consists of a rip rap dike from the northeast point of SRI southward for approximately 5,400 feet and then curving towards the west and west/north. The backend of the rip rap dike alignment ties back into the island. The dredged material placement site also includes several breaks in the structure for site flushing and fish passage. Dredged material from the Pascagoula River Harbor will be placed in this site; therefore, the Pascagoula River Harbor DMMP capacity constraints and the distance from the Bayou Casotte dredging effort would preclude use of this site for new work and O&M dredged material.

Littoral Zone Placement Area Measure

An existing Littoral Zone Placement Area is located west of Horn Island Pass along the shallow shoals exposed to the open Gulf waves with the greatest sand transport potential to the downdrift barrier islands. The LZPA historically has been utilized for sandy material placement to continue natural east-to-west migration of material. The movement of sandy material supplements the barrier island system. This placement area has been positioned within this location to maximum sand migration. Sandy material dredged during new work and O&M efforts adjacent to the Horn Island Pass could be placed within the LZPA as a beneficial use of dredged material. Dredged material with appropriate sand content would increase the amount of sediment (particularly sand) transported along the coast at an angle to the shoreline (also known as littoral drift), thereby helping to supplement sands deposited to the barrier islands via littoral currents. The use of this sandy material is in compliance with RSM Operating Principles.

Use of finer grained material from other areas within the navigation channel would not be suitable for use by various resources agencies, such as the NPS. This measure was identified as a component of various possible alternatives.

Grand Batture Island Measure

Grand Batture Island was located in the southern portion of Grand Bay National Estuarine Research Reserve (NERR) in the waters of Point Aux Chenes Bay. The Grand Bay NERR is located in Jackson County, Mississippi just east of the City of Pascagoula. The Grand Bay NERR's boundaries include the Mississippi-Alabama State line on the east, the communities of Pecan, Kreole, and Orange Grove on the north, the Chevron facility on the west, and Mississippi Sound on the south. The Grand Bay NERR is part of the Grand Bay watershed and encompasses approximately 18,000 acres of a combination of estuarine tidal marsh, shallow open-water areas, non-tidal wet pine savanna, and coastal swamp habitats.

According to the U.S. Coast and Geodetic Survey Chart #328 from 1896, a 4.8-mile long continuous spit extended east and west from the marsh South Rigolets Island. Grand Batture Island was once approximately centered on South Rigolets Island near the Alabama-Mississippi State line. The island was the boundary between Grand Bay, Alabama and Point Aux Chenes Bay, Mississippi, and Mississippi Sound. Grand Batture Island once protected Point Aux Chenes and Grand Bays from erosion; however, during the past century, the island has eroded completely away. Today, only a submerged remnant consisting of a relatively shallow shoal discloses where the island once existed. Loss of the island has exposed the formerly quiet bays to increased wave energy, resulting in the loss of formerly productive oyster beds and the rapid erosion of valuable marshes along the coastlines of those bays.

The Grand Batture remnant shoal is several miles away from the proposed improvement project. In addition, other than the material adjacent to Horn Island Pass within the littoral drift, dredged material predominantly consists of silts and clays, which is not the sandy suitable material desired to restore Grand Batture Island. Furthermore, should the Grand Bay NERR concur with use of this material, a containment structure would be necessary to retain material within the footprint. Given the distance, physical quality of dredged material, and containment requirements, this disposal measure was eliminated from any further consideration.

Round Island

Over time Round Island has experienced beach erosion due to storms and wave action. Restoration of lost acreage by beneficially placing dredged material adjacent to the island could re-establish eroded land. Historically, the areal extent of the island was approximately 150 acres but was only approximately 45 acres after restoration work in 2002. The MDMR completed the first phase of a

constructed beneficial use site in 2014 of 20 acres. A second phase expanded the site to 220 acres. Completed improvements in 2016 to Pascagoula Harbor's Upper Pascagoula Channel and Pascagoula River Channel placed 3.6 million cys of suitable dredged material at Round Island Beneficial Use Site. If the improvements project is constructed and dredged material could be placed within the site with its existing equipment in a feasible manner by the non-Federal sponsor, then this measure would be considered further and evaluated. However the distance to the beneficial use site from the channel as well as the relative small size of the of beneficial use site make this an unlikely alternative.

Figure 3.5.8.4-1: ***Potential Beneficial Use Sites in Vicinity***

Other Potential Beneficial Use Habitat Restoration and Enhancement Opportunities Measure

In addition to the previously identified potential Beneficial Use sites, the USACE Mobile District and the JCPA will continue to explore and evaluate alternative dredge material placement options involving Beneficial Use to restore and create coastal habitat in partnership with MDMR and the Mississippi Beneficial Use Group. Additional Beneficial Use opportunities to explore may include additional project locations for habitat creation and/or restoration of wetland elevations within or adjacent to existing subsiding and eroding marshlands within Mississippi Sound and adjacent bay systems.

3.6 Evaluation of Alternative Plans

As mentioned, study measures are combined to form a plan or alternative. Measures not ruled out for reasons provided can be grouped in different combinations to address the identified problems. Table(s) 3.6-1 and 3.6-2 display the final array of study dredging and placement measures which then are combined to form Alternatives 1 through 18. As noted in the preceding text, each of the non-structural measures were eliminated from further consideration for the reasons noted. Therefore, the remaining measures became alternatives and are shown below. These alternatives will be assessed to determine how well they address the identified existing and forecast future operational inefficiencies of the harbor. As such, each alternative will be evaluated based upon how well it meets/exceeds the stated planning objectives and constraints and the volume of material generated from proposed dredging, a maximum of approximately 5 million cys associated with proposed alternatives. Additionally, consideration will be given to whether each alternative addresses any of the identified study area opportunities.

Table 3.6-1
Viable Structural Study Alternatives

Measure	Description
No Action	No Improvements and continue O&M dredging and placement activities as currently conducted.
1	50-ft Widening on West Side of Channel
2	100-ft Widening on West Side of Channel
3	150-ft Widening on West Side of Channel
4	50-ft Widening on East Side of Channel
5	100-ft Widening on East Side of Channel
6	150-ft Widening on East Side of Channel
7	25-ft Widening on Both Sides of Channel (total 50-ft)
8	50-ft Widening on Both Sides of Channel (total 100-ft)
9	75-ft Widening on Both Sides of Channel (total 150-ft)
10	50-foot widening on west side of channel with bend easing at Horn Island Pass
11	100-foot widening on west side of channel with bend easing at Horn Island Pass
12	150-foot widening on west side of channel with bend easing at Horn Island Pass
13	50-foot widening on east side of channel with bend easing at Horn Island Pass
14	100-foot widening on east side of channel with bend easing at Horn Island Pass
15	150-foot widening on east side of channel with bend easing at Horn Island Pass
16	25-foot widening on both sides of channel with bend easing at Horn Island Pass (total 50-ft)
17	50-foot widening on both sides of channel with bend easing at Horn Island Pass (total 100-ft)
18	75-foot widening on both sides of channel with bend easing at Horn Island Pass (total 150-ft)

Table 3.6-2
Viable Disposal Alternatives

Disposal Measure	New Work Dredging	O&M Dredging	Description
Open water disposal areas		X	Use of open-water disposal areas 3, 4, 5, 6, 7, 8, and 9. Not exceeding the -4-foot depth
Pascagoula ODMDS	X	X	New work material placed within the ODMDS and some possible future O&M material placement for long-term management of other disposal sites
Littoral Zone Placement Area	X	X	Littoral placement of suitable sandy material from New Work and O&M operations
Other Future Beneficial Use	X	X	Beneficial Use of dredged material at future currently unconstructed sites

The final array of structural alternatives evaluated to address the identified study problems are shown in the following table. Each of the 18 structural alternatives include incremental widening of both the Lower Pascagoula and Bayou Casotte Channels (i.e., by 50 feet, 100 feet and 150 feet). Alternatives 1-3 and 10-12 address channel widening on the west side of the channel, with the latter three alternatives including easing at the channel bends. Alternatives 4-6 and 13-15 include channel widening on the east side of the existing channel segments with bend easing for Alternatives 13-15. Lastly, Alternatives 7-9 and 16-18 include incremental widening on both sides of the channel, with bend easing included in Alternatives 16-18. Improved channel lengths are parallel to the centerline of the channel and vary from 6.01 miles to 7.22 miles in length. Similar to the existing condition, one on five channel side slopes were used for with-project conditions.

Table 3.6-3
Volume of Dredged Material

Alternative	Net Dredged Volume	Est. Littoral Sand Volume	Percent Littoral Sand
Alternative 1 – 50 feet Widening on West Side of Channel	1,523,555	43,401	2.8%
Alternative 2 – 100 feet Widening on West Side of Channel	3,354,532	93,013	2.8%
Alternative 3 – 150 feet Widening on West Side of Channel	4,966,828	146,478	2.9%
Alternative 4 – 50 feet Widening on East Side of Channel	1,639,038	147,440	9.0%
Alternative 5 – 100 feet Widening on East Side of Channel	3,524,904	339,261	9.6%
Alternative 6 – 150 feet Widening on East Side of Channel	5,660,204	544,653	9.6%
Alternative 7 – 25 feet Widening on Both Sides of Channel (total 50 feet)	1,513,174	76,024	5.0%
Alternative 8 – 50 feet Widening on Both Sides of Channel (total 100 feet)	3,272,695	171,525	5.2%
Alternative 9 – 75 feet Widening on Both Sides of Channel (total 150 feet)	4,967,338	304,620	6.1%
Alternative 10 – 50 feet Widening on West Side of Channel with Bend Easing	1,569,094	85,583	5.4%
Alternative 11 – 100 feet Widening on West Side of Channel with Bend Easing	3,604,064	247,032	6.9%
Alternative 12 – 150 feet Widening on West Side of Channel with Bend Easing	5,311,063	191,280	3.6%

Alternative 13 – 50 feet Widening on East Side of Channel with Bend Easing	1,700,876	204,644	12.0%
Alternative 14 – 100 feet Widening on East Side of Channel with Bend Easing	3,588,060	410,441	11.4%
Alternative 15 – 150 feet Widening on East Side of Channel with Bend Easing	5,723,833	627,076	11.0%
Alternative 16 – 25 feet Widening on Both Sides of Channel with Bend Easing (total 50 feet)	1,566,479	128,277	8.2%
Alternative 17 – 50 feet Widening on Both Sides of Channel with Bend Easing (total 100 feet)	3,288,392	310,678	9.4%
Alternative 18 – 75 feet Widening on Both Sides of Channel with Bend Easing (total 150 feet)	5,005,661	351,851	7.0%

A total of 19 alternatives (18 structural alternatives and a No Action Alternative) were carried forward in the *Environmental Effects* section, which follows.

4 ENVIRONMENTAL EFFECTS

4.1 Introduction

This section presents the environmental and socioeconomic consequences of implementing the No Action, Proposed Action and Other Alternatives evaluated in the EIS. The Proposed Action and Other Alternatives evaluated in the EIS were discussed in Sections 3.0. Formulation of improvements at Pascagoula Harbor's Bayou Casotte and Lower Pascagoula Channels resulted in identifying an alternative *maximizing the net benefits* but was also greater than the *LPP alternative*. The Proposed Action (i.e. identified as the *tentatively selected plan* in the Feasibility Study) is the following LPP alternative:

> Alternative 11 – 100-foot westward widening improvements with bend easing into Horn Island Pass for an approximate total length of 38,200 feet. Placement of new work dredged material placed within the Pascagoula ODMDS and beneficially at the LZPA. Projected time to complete project construction is anticipated to be approximately 18 months. Future O&M dredging of that improved navigation channel with placement within existing open-water sites, the LZPA, Pascagoula ODMDS, and other possible beneficial use site(s) should it become available.

Performing an evaluation of environmental consequences for the Proposed Action is a requirement of NEPA (40 CFR §1500-1508). The EIS addresses the potential impacts of the proposed project on the natural and human environment. An impact is defined as a consequence from modification to the existing environment due to a proposed action or alternative. Impacts can be beneficial or adverse, can be a primary result of an action (direct) or a secondary result (indirect), and can be permanent or long-lasting (long-term) or temporary and of short duration (short-term). Impacts are evaluated for significance in terms of context and intensity. An impact analysis must be compared to a significance threshold to determine whether a potential consequence of an alternative is considered a significant impact. An impact is considered either less than significant or significant. If the impact is significant, it may be mitigatable (i.e., measures are available to reduce the level of impact to less than significant) or unmitigatable.

4.2 Physical Environment

4.2.1 Geology

The significance criterion for the geology of the Bayou Casotte Harbor Channel Improvement Project would be a permanent change in underlying bedrock that interferes with the natural movement and deposition of sediments in Mississippi Sound.

4.2.1.1 Geology Alternative A (No Action)

Selection of the No Action alternative would result in no impacts to geological resources within the project study area. However, sedimentation in the channel and regularly scheduled maintenance dredging performed by the USACE, Mobile District would result in periodic, slight changes to the bottom depths of the existing maintained channel. There would be no impacts to the underlying geology.

4.2.1.2 Geology - Proposed Action (Alternative 11)

Sediments contained within the widened dimensions and defined in the dredge prism would be removed by either a hopper, mechanical, or cutterhead dredge (or combination) under the Proposed Action. Up to approximately 3.6 million cys of new work dredged material plus up to an additional 2.7 million cys of maintenance dredged material from the existing channel could be removed from the dredging prism (see *Table 4.2.1.2-1*). The initial new work material would be placed in the LZPA and/or the Pascagoula ODMDS. Future O&M material would be placed in previously designated open-water disposal sites adjacent to the channel, LZPA, and/or the Pascagoula ODMDS. Through continued maintenance of the improved channel, the removal of those sediments would be permanent. The Proposed Action would not change underlying bedrock or interfere with the natural movement and deposition of sediments in Mississippi Sound. However it should be noted that impacting bedrock in this area would be unlikely, if not impossible, considering the depth required to reach underlying bedrock.

Table 4.2.1.2-1: ***Alternatives – No Action, Proposed Action, and Other Alternatives Quantities and Impact Acres***

Alternative	New Work (cys)	Future Total O & M (cys)	Acres to be Impacted (new)
Alternative A (No Action)	0	2,160,000	0*
Alternative 1	1,523,555	2,413,000	35.54
Alternative 2	3,354,532	2,672,000	73.15
Alternative 3	4,966,828	2,936,000	112.26
Alternative 4	1,639,038	2,426,000	40.15
Alternative 5	3,524,904	2,701,000	82.38
Alternative 6	5,660,204	2,996,000	125.27
Alternative 7	1,513,174	2,410,000	37.24
Alternative 8	3,272,695	2,682,000	75.29
Alternative 9	4,967,338	2,926,000	114.53
Alternative 10	1,569,094	2,422,000	37.95
Alternative 11 (Proposed Action)	3,604,064	2,679,000	75.02
Alternative 12	5,311,063	2,941,000	113.61
Alternative 13	1,700,876	2,437,000	43.16
Alternative 14	3,588,060	2,713,000	85.57
Alternative 15	5,723,833	3,007,000	128.59
Alternative 16	1,566,479	2,420,000	39.94
Alternative 17	3,288,392	2,691,000	77.77
Alternative 18	5,005,661	2,934,000	116.82

**It is acknowledged that Alternative A currently impacts acres under existing O&M actions, however this column represents new acres to be impacted.*

4.2.1.3 Geology Alternative (All others)

Table 4.2.1.2-1 identifies the new work and O&M quantities associated with each improvement and future O&M alternative. In addition, the acres to be impacted are also included in this table. These alternative(s) would result in impacts that would be less than significant.

4.2.2 Bathymetry

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

4.2.2.1 Bathymetry Alternative A (No Action)

The No Action Alternative would not have long-term effects to bathymetry in Mississippi Sound around the Bayou Casotte area. Maintenance dredging associated with the No Action Alternative would continue to remove deposition in the existing channel and not alter bathymetry significantly since the channel would remain at its current width and depths. Under the No Action Alternative, bathymetric conditions would remain as existing conditions.

4.2.2.2 Bathymetry - Proposed Action (Alternative 11)

The Proposed Action would generate up to approximately 3.6 million cys of new work dredged material plus up to an additional 2.7 million cys of maintenance dredged material. Where the Pascagoula Harbor Navigation Channel extends across the Mississippi Sound, the northern half of that portion of the Sound has natural water depths of about –13 feet MLLW or less. Depths in the southern half of the Sound range from approximately –13 to –20 feet MLLW. South of Horn Island, natural depths range from approximately –20 to –45 feet MLLW in the vicinity of the ship channel. The widening of the existing channel would result in a permanent change in local bathymetry from depths as shallow as –13 feet to –42 feet plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. Approximately 75.02 acres of shallow estuarine bottoms would be permanently changed as a result of the proposed action. However, this change would not result in bathymetric effects outside of the area of physical disturbance and based on the relative small size as compared to the remaining area in Mississippi Sound, the permanent alternation would be minor. Impacts would be less than significant.

4.2.2.2.1 Placement of Dredged Material within the Littoral Zone Area

Sandy material would be placed in the LZPA to supplement the westward littoral drift throughout the barrier island system. Approximately 248,000 cys of sandy material could be placed within the LZPA. *Table(s) 3.7.3-1* and *4.2.1.2-1* provide the quantities of material for the Proposed Action. The area south of Horn Island is a preferred location for placement of sandy sediments. Sandy material – both new work and O&M - from dredging could be placed in the littoral zone which would result in less than significant impacts on bathymetry.

4.2.2.2.2 Placement of Dredged Material within the Existing Open-Water Sites

The existing open-water sites located along the west side of the Lower Pascagoula Channel and east of the Bayou Casotte Channel would be used to accommodate the dredged material generated by future maintenance of the newly widened channel between the offshore islands and Bayou Casotte Harbor. Some of the materials placed in these sites would be reworked by currents within Mississippi Sound and supplement the littoral drift system. Other sediments would accumulate in place. The final elevation of the sediment surface at the open-water sites would increase somewhat, relative to the existing sediment elevation. Compaction, consolidation, and break-down would occur over time, reducing this effect. Some transport and deposition of re-suspended sediments would likely occur during higher wave and storm events. However, a review of bathymetry change data from 1917 to 1971 does not indicate that significant deposition would occur outside of those areas immediately adjacent to the navigation channels where historic side casting occurred (USACE, 2007b). In addition, these open-water disposal areas depths would not exceed -4 feet MLLW to ensure safe passage of commercial and recreational vessels outside of the navigation channel. Any impacts on bathymetry would be less than significant.

4.2.2.2.3 Placement of Dredged Material within the Pascagoula ODMDS

The Pascagoula ODMDS encompasses an area of approximately 24.3 square nm south of Horn Island and ranges from depth of about 30 feet in the northern part to over 60 feet in the southern section. The Pascagoula ODMDS is intended for placement of dredged material from maintenance and new work from the Pascagoula Harbor Navigation Channel, maintenance material from the channels and turning basin associated with the former Naval Station Pascagoula, and maintenance activities by private entities, such as Huntington Ingalls and the Chevron Refinery. Impacts associated with placement of dredged material in the Pascagoula ODMDS were analyzed in the FEIS for the designation of an ODMDS located offshore of Pascagoula (USEPA, 1991). Any impacts to bathymetry from placement of dredged material from the Proposed Action in the Pascagoula ODMDS would be less than significant since the area was designed as a placement area and the dredged material testing indicates the material is acceptable for open-water disposal.

4.2.2.3 Bathymetry Alternative (All Others)

The other alternatives would generate up to approximately 5.7 million cys of new work dredged material, plus up to an additional 3 million cys of maintenance dredged material. The widening of the existing channel would result in a permanent change in local bathymetry from depths as shallow as -13 feet to 42 feet, plus 2 feet of advanced maintenance and 2 feet of overdepth dredging. Up to approximately 627,000 cys of sandy material could be placed within the LZPA. The existing open-water sites located along the west side of the Lower Pascagoula Channel and east of the Bayou Casotte Channel and/or LZPA would be used to accommodate the dredged material generated by future maintenance of the newly widened channel between the offshore islands and Bayou Casotte Harbor. Any impacts to bathymetry from placement of dredged material from the Proposed Action in the Pascagoula ODMDS would be less than significant since the area was designed as a disposal area and the dredged material testing indicates the material is acceptable for open-water disposal. *Table(s) 3.5.3-1* and *4.2.1.2-1* provide the quantities of material for the proposed action and other alternatives. These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.2.3 Oceanography

The significance criteria for physical oceanography would be a permanent disruption in current and tide patterns or a permanent adverse change in salinity in the Mississippi Sound.

4.2.3.1 Oceanography Alternative A (No Action)

Conditions would remain as they are under the No Action Alternative. No impacts to the existing circulation patterns, tides, wave action, or salinity distribution would be expected as a result of the No Action Alternative.

4.2.3.2 Oceanography - Proposed Action (Alternative 11)

The widening of the existing channel would not be expected to cause changes to the overall circulation or salinity patterns beyond localized changes. The circulation patterns in the Bayou Casotte Harbor area are directly affected by tidal influences correlated to Horn Island Pass. In this eastern portion of Mississippi Sound, a general clockwise movement of water occurs (USEPA, 1991). In the nearshore shallow areas around the barrier islands, wind and pressure forces dilute the tidal influences on circulation, culminating in highly variable water movement (USEPA, 1991). The proposed channel widening would make up approximately 0.001 square mile of the total 1,850 square miles of the Mississippi Sound and is not anticipated to impact the overall coastal processes in the Sound due to the large scale at which coastal processes occur. Based upon those recent ERDC sensitivity studies,

the following is anticipated for circulation, and water quality. A water quality model study of the Mississippi Sound was conducted to determine potential impacts (i.e. change to existing water quality, and quantification of relative changes in water quality and flushing capacity) from the proposed action and alternatives. Two numerical models, one hydrodynamic (CH3D) and one water quality model (CEQUAL-ICM) were applied to the study area to simulate hydrodynamics and water quality in Mississippi Sound. In addition to the calibration/base grid (existing conditions), a total of 2 configurations were modeled - East Widening and West Widening. Changes in DO, salinity and chlorophyll A were an indicator of changes to water quality. Changes to salinity and chlorophyll were greater than DO changes but were still considered insignificant. Although water quality changes were noted, all were within the state standard for constituents of interest for oceans waters. Analysis of time series of the flows at these locations indicates that neither the East Widening nor the West Widening would significantly alter the magnitude of the flood or ebb flow at the locations evaluated.

Therefore it is logical to deduce that the transport of material in the water column will not be adversely altered from current levels and flushing conditions of the East Widening and West Widening cases would be as good as if not better than the existing conditions in Bayou Casotte. Overall, comparison of results from the widening to the East and widening to the West runs showed slight changes in circulation but caused minor effects to water quality concentrations in the area of modifications. Both scenarios showed similar impacts to water quality. However, it is concluded from these results that none of the modifications simulated would have detrimental water quality impacts. Thus, altering the width of the navigation channel would not be expected to change the circulation patterns in the area of concern. Salinity in the project study area is irregular, being influenced by river and tidal plumes, Loop Current intrusions, and the existing ship channel (Eleuterius, 1976; USEPA, 1991). The proposed channel improvements would be expected to result in only minor, if any, changes to existing salinity distribution patterns and the impacts would be less than significant.

There would be localized small-scale changes in current patterns in the immediate areas where littoral zone placement would occur. Material would be placed in littoral zone areas to supplement the littoral drift system. Littoral zone placement could result in minor changes in salinity and temperature in these areas, but wave and current action would quickly rework and spread this material westward into the Mississippi Sound. Any impacts would be less than significant.

Future maintenance material being placed in existing open-water sites and the LZPA located along the west and east sides of the Lower Pascagoula and Bayou Casotte Channel(s), respectively, could result in localized small-scale changes in physical and chemical properties of the water column, but wave and current action would quickly remix and homogenize the water. Any impacts on physical oceanography would be less than significant.

Placement of dredged material in the Pascagoula ODMDS would result in localized changes in physical and chemical properties of the water column, but wave and current action would remix and homogenize the water. This site has historically been utilized for placement of large scale navigation projects and its depth is sufficient that no changes to wave energy or current directions would be anticipated. Any impacts would be temporary and minor. Changes in ocean currents, tides, wave action, or salinity distribution would not be expected to result from using the ODMDS for placement of dredged sediments. Detailed studies with the designation of the site in the 1991 FEIS evaluated changes in the oceanographic setting and found it to be less than significant.

4.2.3.3 Oceanography Alternative (All Others)

The impacts to oceanography would be essentially the same as discussed in Section 4.2.3.2. These alternative(s) would result in impacts that would be less than significant.

4.3 Sediments

The significance criteria for sediments in the vicinity of the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels would be a change in sediment characteristics that results in a permanent change in sediment characteristics; a change in grain size and consistency; a temporary decline in water quality as a result of sediment/water interactions; or a decline in sediment quality that causes permanent impacts to biological resources.

4.3.1 Sediments Alternative A (No Action)

The No Action Alternative would result in impacts similar to those of the channel dredging and placement in the open-water, LZPA, and Pascagoula ODMDS that currently exist associated with ongoing maintenance dredging. Maintenance dredging of the ship channel is ongoing and deposition of the dredged material at historic placement sites would result in minor, short-term and temporary impacts that have been previously assessed and documented.

4.3.2 Sediments - Proposed Action (Alternative 11)

Sedimentation impacts resulting from the Proposed Action would be minimal in the existing and expanded channel as the dredged material would be transported away and placed in the ODMDS, LZPA, or historic open water sites. Table(s) 3.5.3-1 and 4.2.1.2-1 provide the quantities of material for the Proposed Action. Sediments located in the Mississippi Sound consist of fine particles and any re-suspended sediment during transporting of dredged material for placement would consist of similar material. There is little sediment being introduced by a river system into the area of Mississippi Sound in the vicinity of the Bayou Casotte Improvements project. The project area is north of the active littoral zone within the barrier islands. Some sediment re-suspension by waves and tidal processes would likely occur which could result in turbid water; however, this would be temporary in nature and would be similar to what currently exists throughout the system during any period of high winds, storm events, and high tides. These impacts associated with re-suspension and resettling would be less than significant.

The sandy sediment placed in the LZPA would be dredged from the Horn Island Pass reach of the channel. The sandy material would result in less than significant impacts. Finer material would be resorted by wave and current action and would be reworked and spread along the coast and into the Mississippi Sound. The impacts associated with placement in the LZPA would be less than significant. The USACE, Mobile District evaluated the proposed dredged material to be removed from the navigation project based on its physical, chemical and biological parameters and found it suitable for placement within upland, open-water, and ocean disposal sites.

Dredged material would be placed in the existing open water disposal areas and the LZPA during future maintenance of the improved channel. Localized changes in sediment characteristics in the immediate disposal areas could occur; however, substrate changes would not be expected as sediment characteristics would be similar to those of existing sediment. Wave and current action would quickly rework the dredged material into the surrounding sediments. Any impacts on sediment characteristics would be less than significant.

Any changes in sediment characteristics associated with placement in the Pascagoula ODMDS would be temporary and minor. Natural processes would rework the deposited material into the surrounding sediments. Any impacts would be less than significant within the boundaries of the ODMDS.

4.3.3 Sediments Alternative (All Others)

Table(s) 3.5.3-1 and 4.2.1.2-1 provide the quantities of material for the proposed action and other alternatives. Sedimentation impacts from these other alternatives would be similar to that described for the Proposed Action above. These alternative(s) would result in impacts that would be less than significant.

4.4 Climate

Changes to climate, specifically changes in temperature and precipitation, is understood to affect the water balance of river systems and connected estuarine systems. Changes to climate, as expressed in the Mississippi Gulf Coast, would be expected to alter freshwater flows from the Pascagoula River to Pascagoula Bay. These changes in freshwater flows would change estuarine salinity and circulation regimes, but the magnitude and details of these changes is unknown. The cumulative effects of these changes, in concert with implementation of the proposed project, are not known with enough detail to support further assessment.

The significance criterion for climate would be a permanent disruption in the climate and weather patterns in Mississippi Sound or the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte project area.

4.4.1 Climate Alternative A (No Action)

With the No Action Alternative, the USACE, Mobile District would continue to maintain the existing navigation channel at Pascagoula Harbor to its federally authorized depth(s). The No Action Alternative would have no impact on climatic conditions in the area.

Even under the No Action Alternative, the region will undergo changes as a result of sea level rise. Given the uncertain nature of sea level rise projections, the effects of sea level rise are not discussed as certain impacts, but as vulnerability. Under the No Action Alternative, existing placement of dredged material to help maintain sediment budgets would continue.

No sea level rise vulnerability assessments were found for the Bayou Casotte region. Similarly, an adaptation assessment for Bayou Casotte and the surrounding region has not occurred. These facts limit the depth of analysis that is possible. Reports are available that examine the region's barrier islands vulnerability to the influence of sea level rise and changes to climate.

The barrier islands, Horn Island and Petit Bois Island, are dynamic landforms that change in response to storm frequency and intensity, relative sea level rise, and sediment supply. Historically these islands have eroded.

The volume of sand supplied to these barrier islands by longshore currents has been reduced since the late 1800s as the outer bars at the entrance to Mobile Bay, Horn Island Pass, and Ship Island Pass were dredged to increasingly greater depths (Byrnes 2010). Horn Island and Petit Bois Island are separated by Horn Island Pass and the Pascagoula Channel. The Horn Island Pass Channel has not been stabilized by hard structures, such as jetties. Sediment that would nourish the barrier islands along this coastline is typically bypassed by the dredging of these navigational channels to promote littoral movement.

The MsCIP effort, as part of the USACE, Mobile District, has prepared an EIS to supplement the Comprehensive Plan & Integrated Programmatic EIS for the restoration of the barrier islands. Without the MsCIP program, continued rapid land loss from barrier islands is anticipated as a result of rising sea level, frequent intense storms, and reduced sediment supply.

4.4.2 Climate - Proposed Action (Alternative 11)

Air emissions from the Proposed Action Alternative will result from the operation of dredges, the support vessel, the multi-purpose construction vessel and the land-side construction equipment powered by internal combustion engines that produce exhaust emissions. Emissions from this equipment will result in an increase in greenhouse gas emissions that could contribute to global climate change. To date, specific thresholds to evaluate adverse impacts pertaining to greenhouse gas emissions have not been established by local decision-making agencies, the state, or the Federal government.

Widening the Bayou Casotte and Lower Pascagoula Channels at varying dimensions would not cause changes in climatic conditions in the project study area. No impacts would be expected as a result of the Proposed Action.

4.4.3 Climate Alternative (All Others)

Similar impacts as discussed in Section 4.4.2 would be anticipated for all other alternatives identified. Widening the Bayou Casotte and Lower Pascagoula Channels at varying dimensions would not cause changes in climatic conditions in the project study area.

4.5 Air Quality

The significance criterion for air quality would be the Air Quality standards are not violated by the implementation of the alternatives or that Air Quality would not be degraded from present conditions in the vicinity of the Pascagoula area. It addresses both direct and indirect effects and discusses their impacts relative to the inventory of air emissions for the Jackson County area.

The evaluation of impacts to air quality associated with the alternatives was based on the identification of air contaminants and estimated emission rates. The air contaminants considered are those covered by the NAAQS and monitored by Jackson County including carbon monoxide, ozone, nitrogen oxide, particulate matter with diameters less than 10 microns, particulate matter less than 2.5 microns in diameter, and sulfur oxides.

The construction and O&M sequences for the proposed project alternatives are very similar and require the excavation, transport, and deposition of the dredged material into the approved placement areas. Air emissions were considered for channel widening and O&M activities and emissions from vehicular traffic associated with the project employee commute for the alternatives. Air emissions were also estimated for activities associated with relocation of the centerline ranges by the USCG.

4.5.1 Air Quality Alternative A - No Action

Under the No Action Alternative, any changes to existing air quality conditions that would result from continued maintenance dredging in the Bayou Casotte Navigation Channel and subsequent placement of dredged material are expected to be temporary and minor. Pascagoula Harbor is an industrialized area with routine heavy equipment operating. The area is within NAAQS attainment. Impacts of the No Action Alternative are not expected to be significant.

4.5.2 Air Quality - Proposed Action (Alternative 11)

Air emission sources for the Proposed Action Alternative will consist of harbor vessels and land-based mobile sources that will be used during the channel widening activities and future O&M of that improved navigational feature, as follows:

- Harbor Vessels – dredges, support vessels, and a multipurpose construction vessel; and
- On-road vehicles including one work truck and private employee vehicles.

Air contaminant emissions associated with this alternative would be primarily combustion products from fuel burned in equipment used for project dredging, construction and on-road vehicles. The harbor vessel emission sources will be diesel-powered engines. The on-road vehicles were all assumed to be gasoline-powered. Air emissions estimates for vessels utilize hp as a component of the calculation. Cutter suction dredges are more efficient and use less energy when compared with hopper dredges although a combination of dredges is anticipated, emissions estimates provide conservative vessel emission estimates. Overall vessel transit(s) are not expected to increase.

Currently, all areas within coastal Mississippi are in attainment with the NAAQS. Air quality in the immediate vicinity of the project would be slightly affected for a period of time during construction activities by the fuel combustion and resulting engine exhausts. However, the standards would not be violated by the implementation of the proposed project.

4.5.3 Air Quality Alternative (All Others)

Similar impacts are anticipated for all other alternatives. These alternative(s) would result in impacts that would be less than significant.

4.6 Noise

There are no noise restrictions that apply to this area. The significance criteria for the noise impacts in the vicinity of the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels 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 receptors. Disrupting nesting behavior in marine birds would be a significance criterion for surface noise, while behavior of marine mammals is a consideration for underwater noise.

The significance criterion for underwater noise in the vicinity of the project study area would do one or more of the following:

- Cause a permanent or long-term population avoidance of the area;
- Cause a temporary threshold shift (TTS) or permanent threshold shift (PTS) of marine life;
- Cause stranding, organ damage, or death to marine life; or
- Disrupt nesting behavior in marine birds, resulting in the loss of an age cohort of a species.

4.6.1 Noise Alternative A - No Action

The No Action Alternative, continuing to maintain the existing navigation channel with the present dimensions via maintenance dredging, would cause a slight increase in existing noise conditions in the vicinity of the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channels. However, marine species in the vicinity of the shipping channel and elsewhere in the Gulf of Mexico have coexisted with ongoing maintenance dredging operations. Maintenance activities occur approximately every 18 months in the Lower Pascagoula Channel and every 12 months in the Bayou Casotte Channel. Therefore, any noise impacts from the No Action Alternative would be temporary and minor, and restricted to avoidance or temporary disruption of foraging or movement.

4.6.2 Noise - Proposed Action (Alternative 11)

It is unlikely that underwater sound from dredging operations will cause injury to humans and/or fish and wildlife in the project or study area. In addition, the noise levels would not exceed those already occurring in the harbor due to ship traffic or due to existing maintenance dredging. Noise from dredging and placement operations (i.e. improvements and future O&M) is expected to increase during those operational activities in the project vicinity. Noise levels will resume to existing conditions as construction and O&M activities are completed. Maintenance activities occur approximately every 18 months in the Lower Pascagoula Channel and every 12 months in the Bayou Casotte Channel. The nearest noise sensitive receptors include a residential area along Southshore Avenue and recreation areas (Singing River Yacht Club) located about 1 mile northeast of the project area. Two churches and four schools are located 1.5 to 2 miles northeast of the northern project footprint. All of the noise sensitive receptors are located closer to industrial facilities operating at the Bayou Casotte Harbor than where the proposed action would occur. The distance from schools and residential areas and the typical high background noise levels around the industrial harbor indicate that noise levels from the Proposed Action would not affect the surrounding population.

Seabirds and shorebirds may be sensitive to noise from dredging and placement activities; however, the continued presence of bird populations in the industrial port area indicates these birds have a tolerance for industrial noise. Any displaced bird species from potential foraging areas by noise from dredging and placement activities would be expected to resume use of the area following completion of the work. Bird species using the barrier islands may be temporarily displaced from potential roosting areas due to noise; however this effect would be short in duration and temporary (overall project construction is estimated at 18 months, but time spent near the barrier islands would be substantially less) and conditions would return to normal after completion of the work.

Underwater noise is reported to have a wide variety of effects on marine mammals including temporary avoidance, long-term avoidance, stranding, organ damage, and death. These responses vary depending on sound intensity, distance, sound frequency, and acoustic sensitivity of the species potentially affected. Different marine species are sensitive to different sound frequencies and propagation of sound through water varies by frequency.

The MMPA establishes underwater noise standards and defines harassment as any act of pursuit, torment or annoyance that:

i. has the potential to injure a marine mammal or marine mammal stock in the wild (Level A Harassment), or

ii. has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering (Level B Harassment).

As defined by the MMPA, dredging operations could result in harassment of marine mammal species if the mammals are in close proximity to an operating dredge. However, this would be a temporary condition and the mammals can swim around the disturbance.

The Proposed Action would take place over a relative short duration (18 months estimated for total project construction). Noise in the outside environment associated with the dredging and placement activities would be expected to minimally exceed normal ambient noise in the project area; however, construction noise would be attenuated by background sounds from wind and surf. In-water noise would be expected in association with the dredging and placement activities for this project. Specifically, noise associated with dredging could occur from (1) ship/machinery noise—noise associated with onboard machinery and propeller and thruster noise, (2) pump noise—noise associated with pump driving the suction through the pipe, (3) collection noise—noise associated with the operation and collection of material on the sea floor, (4) deposition noise—noise associated with the placement of the material within the barge or hopper, and (5) transport noise—noise associated with transport of material up the suction pipe. The limited available data indicate that dredging is not as noisy as seismic surveys, pile driving and sonar; but it is louder than, for example, most shipping, operation of offshore wind turbines and drilling (Thomsen et al. 2009).

Dredging produces broadband and continuous, low-frequency sound (below 1 kHz) and estimated source sound pressure levels range between 168 and 186 dB reference (re) level of 1 µPa at 1 m (A micropascal (µPa) is a measurement of pressure commonly applied to underwater sound and 1 pascal is equal to the pressure exerted by one newton over one square meter), which can trigger avoidance reaction in marine mammals and marine fish. In some instances, physical auditory damage can occur. Auditory damage is the physical reduction in hearing sensitivity due to exposure to high-intensity sound and can be either temporary (TTS) or permanent (PTS) depending on the exposure level and duration. Other than physical damage, the key auditory effect is the increase in background noise levels, such that the ability of an animal to detect a relevant sound signal is diminished, which is known as *auditory masking*. Masking marine mammal vocalizations used for finding prey, navigation and social cohesion could compromise the ecological fitness of populations (Compton et al. 2008).

4.6.3 Noise Alternative (All Others)

Potential noise impacts resulting from the other alternatives would be the same as those described under the Proposed Action in Section 4.6.2. These alternative(s) would result in impacts that would be less than significant.

4.7 Water Supply

4.7.1 Water Supply Alternative A - No Action

With the No Action Alternative, the USACE, Mobile District would continue to maintain the existing Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channel(s) to current depth and width via maintenance dredging. No diversion structure(s) and/or changes in land use would be implemented under the No Action Alternative. Thus, no impact on water supply in the area would occur.

4.7.2 Water Supply - Proposed Action (Alternative 11)

There should be no effect on water supply in the project area. The improvements to the navigational project would avoid impacts to existing public water supply infrastructure and operating facilities.

4.7.3 Water Supply Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.8 Marine Sanctuaries

4.8.1 Marine Sanctuaries - All Alternatives

There are no impacts associated with any identified alternative as there are no marine sanctuaries within the vicinity of the project area. There is, however, one National Marine Reserve, Grand Bay NERR, located approximately 2.5 to 3 miles east of the study area.

4.9 Aesthetics

4.9.1 Aesthetics Alternative A - No Action

The No Action alternative, continuing to maintain the existing navigation channel with the present dimensions via maintenance dredging using a variety of heavy equipment, would cause a slight temporary impact to aesthetics; however, aesthetics within the project site would remain as they currently exist.

4.9.2 Aesthetics - Proposed Action (Alternative 11)

As the project is constructed, aesthetics would be temporarily impacted in the immediate vicinity of the project site; however, the project is located in a highly industrialized port area and the presence of the construction equipment would be similar to the type of equipment commonly seen in the area. Dredging activities and future maintenance activities would be short in duration and temporary in nature (18 months for project construction over a 7-mile area, however spending a relative short amount of time in each channel section), so any impacts would be minimal. The proposed project would result in no obvious changes to the appearance of the Bayou Casotte and Lower Pascagoula Channel once completed. Furthermore, vessels currently call upon the Port and are anticipated to still utilize the Port in the future. The impacts associated with the Proposed Action would be less than significant.

4.9.3 Aesthetics Alternative (All Others)

These alternative(s) would result in similar impacts as discussed in Section 4.9.2 that would be less than significant.

4.10 Cultural Resources

Any construction activity has the potential for adversely impacting cultural resource sites. Because this action requires Federal funding, permitting or assistance, Federal regulations established under Section 106 of the NHPA of 1966, as amended, provide standards for considering the severity of possible direct and indirect impacts. According to the Secretary of the Interior's regulations for

protection of historical and archaeological resources, adverse impacts may occur directly or indirectly when a project causes changes in archaeological, architectural or cultural qualities that contribute to a resource's historical or archaeological significance.

Direct impacts to cultural resource sites may occur during the construction phase of the proposed project and cause physical destruction or alteration of all or part of a resource. Typically, direct impacts are caused by the actual construction or as with this project, at the same time and location as dredging. Construction of the proposed project may directly alter, damage, or destroy historic shipwrecks, engineering structures or landscapes. Direct impacts may also include isolation of a historic resource from or alteration of its surrounding environment (setting).

Indirect impacts include those effects caused by the project that are further removed in distance, or that occur later in time, but are reasonably foreseeable. These indirect impacts may include introduction of visual or audible elements that are out of character with the resource or its setting. Indirect impacts may also occur as a result of alterations in the pattern of land use, changes in population density, accelerated growth rates, or as with this project, increased shoreline erosion from increased nautical traffic. Historic shipwrecks, structures, landscapes, and archaeological sites along the shoreline are among the types of resources that might be adversely impacted by the indirect impact of the alternatives.

Erosion has been occurring at this site along Greenwood Island due to waves, ship wakes, etc. over the years and is expected to occur at the current rate; therefore the mitigation was proposed during construction to alleviate the problem. Erosive forces would occur with both the no action and the tentatively selected plan. Although the tentatively selected plan is not forecasted to increase the number of those ships calling upon the port, the known cultural resources site has historically been impacted by ship wakes and been a concern to the JCPA. Thus, JCPA agreed to proactively implement the mitigative measure to address known and potential future concerns.

4.10.1 Cultural Resources Alternative A - No Action

Under the No Action Alternative, no direct impacts are anticipated, as no new activities would occur (maintenance dredging would continue) (Appendix F). However, current conditions would continue to further erode remaining portions of the previously recorded site 22JA516. Recent attempts to relocate site 22JA618 have failed and the site is likely completely eroded or has been covered with dredged material. Therefore, the No Action Alternative will not have an effect on site 22JA618. Additionally, due to the negative results of the recent remote-sensing survey and subsurface probing undertaken by Earth Search, Inc., the No Action Alternative also will not have an effect on the Mexican War-era burial site associated with Camp Jefferson Davis. In the event that any burials are encountered, the burials will be handled in accordance with discovery procedures in the USACE-prepared Plan for the Treatment of Human Remains.

4.10.2 Cultural Resources - Proposed Action (Alternative 11)

The Proposed Action Alternative has the potential to increase erosion, accelerating impacts to the remaining portions of previously recorded site 22JA516 (USACE 2011a). Recent attempts to locate site 22JA618 have failed and the site is likely completely eroded or has been covered with dredged material. Therefore, the Proposed Action Alternative will not have an effect on site 22JA618. Additionally, due to the negative results of the recent remote-sensing survey and subsurface probing undertaken by Earth Search, Inc., the Proposed Action Alternative also will not have an effect on the Mexican War-era burial site associated with Camp Jefferson Davis. In addition to widening the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Channels, the Proposed Action Alternative would result in placement of dredged material within the designated Pascagoula ODMDS and/or LZPA located east and south of the barrier islands. In addition to these disposal sites, future

O&M dredged material would also be placed at previously designated open-water disposal areas including the LZPA. Because these areas were previously permitted and used for this purpose, previously recorded cultural resources within these areas have already been impacted, mitigated and/or no new or additional impacts to these resources are anticipated under the Proposed Action Alternative. The 1990 DEIS for the Designation and Use of a New ODMDS, Pascagoula, Mississippi, indicates that there are no natural or cultural features of historical importance within or in the vicinity of the proposed ODMDSs. Coordination by letter, dated January 25, 1989, with the Mississippi State Historic Preservation Office (SHPO) indicates that the potential for shipwrecks in open water of these depths is considered extremely low. In addition, since the use of the ODMDS is for placement of dredged material, the possible conflict with unknown natural or cultural resources is reduced" (EPA 1990).

In Fall 2011, limited Phase II testing of site 22JA516 was conducted by Brockington and Associates on behalf of the USACE, Mobile District for the Proposed Action Alternative. During the excavation, a substantial area of intact prehistoric midden was identified and the USACE, Mobile District concluded the site to be eligible for inclusion in the NRHP under Criterion D for its potential to produce important information regarding local and regional prehistoric occupation, including information pertaining to prehistoric cultural chronology, subsistence patterns, intrasite use and mortuary practices (RabbySmith 2012).

To mitigate anticipated impacts to cultural resources that are eligible for listing in the NRHP within the area of potential effect (22JA516), the USACE has entered into an Memorandum of Agreement (MOA) with the MDAH, and the Choctaw Nation of Oklahoma. By letter dated October 23, 2012 the Advisory Council on Historic Preservation (ACHP) determined that their participation in consultation to resolve adverse effects was not needed (see MOA and ACHP letter in Appendix F). The MOA includes a work plan for the archaeological Phase III data recovery of 22JA516. The work plan contains the following: environmental and site-specific cultural overviews, an overview of completed cultural resources work at the site, a research design, Phase III archaeological methods, laboratory and specialized analysis methods, methods for curating materials, public interpretation/education, USACE-prepared plan for the treatment of human remains, and an inadvertent discovery plan. Within this plan, the Phase III archaeological methods includes: a walkover survey/condition assessment, clearing of the work area, limited exploratory excavation, mechanized removal of the upper disturbed sediments, placement of excavation blocks, hand excavation, feature excavation, dewatering of the site, field documentation, collection of samples suited for special analysis, off-site water screening, and soil stripping. Following the investigation, specialized analysis and laboratory processing of collected materials will be undertaken. Unless otherwise specified, all material will be curated at the Charlotte Capers Archives and History (see MOA, Letter from USACE to SHPO- Notice of Adverse Effects – May 15, 2012; Letter from ACHP- Oct 23, 2012 Correspondence located in Appendix F)..

Review of the previously conducted Phase I maritime survey report noted that the authors recommended 11 magnetic anomalies for Phase II archaeological diver investigation. That work was not completed at that time. With the widening of the channel, these anomalies would likely be impacted by the dredging operations. Consequently, the targets have been reassessed to determine their eligibility for inclusion on the National Register of Historic Places prior to new construction. All targets were identified as modern debris, thus No Effects to Historic Properties by the alternatives are expected (Enright 2017).

Should any previously unidentified archaeological artifacts, including human remains, shipwrecks or other cultural resources be encountered during project construction, work would cease immediately in the vicinity of the resource, and the discovery would be reported to the MDAH and the appropriate Federally Recognized Tribes by the USACE, Mobile District immediately.

4.10.3 Cultural Resources Alternative (All Others)

Potential impacts and mitigation under the other alternative(s) would be the same as those described under the Proposed Action Alternative.

4.11 Biological Resources

4.11.1 Plankton 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. Peak plankton abundance occurs from spring through early fall (April-October) in estuaries and coastal areas and during the winter (November-March) in offshore areas. The significance criterion for plankton algae would be a permanent alteration in abundance.

4.11.1.1 Plankton Algae Alternative A - No Action

No change in existing conditions would occur under the No Action Alternative. Plankton and algal communities would continue to experience short-term minor impacts similar to those of the Proposed Action during maintenance dredging activities.

4.11.1.2 Plankton Algae - Proposed Action (Alternative 11)

Typical dredging operations (i.e. construction and O&M dredging and placement) elevate turbidity levels and decrease light transmission due to suspension of materials which could result in a temporary localized reduction in phytoplankton and zooplankton. Turbidity and suspended solids were measured as part of a 1975 USACE study of dredging and placement activities. The study included an evaluation of water quality and plankton in dredged and disposal areas over a 40 square mile grid centered on the Gulfport Harbor Navigation Channel in Mississippi Sound. That study found that plumes were small and localized and solids tended to settle rapidly. Levels of turbidity and suspended solids returned to background levels at dredging and 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 dredging process could support a localized temporary increase in phytoplankton following the completion of dredging. The results of the elutriate analyses and water column bioassays indicate mortality levels were acceptable and no adverse effects from dredging and disposing of material associated with the improvements and future O&M were observed. Planktonic organisms would be carried into and out of the project study area via currents during and after dredging. Impacts would be restricted to localized patches of plankton and temporary in nature. Any impacts would be less than significant. As a result, there would be no potential adverse change in the health of populations, community structure and composition, trophic structure, or system function.

4.11.1.3 Plankton Algae Alternative (All Others)

Other alternatives identified vary in project dimensions (i.e. width of channel improvements) but the overall impacts are no different than those anticipated with the Proposed Action. These alternative(s) would result in similar impacts described in Section 4.11.1.2 that would be less than significant.

4.11.2 Benthic Invertebrates

Benthic invertebrates are good indicators of the health of an estuarine system and are useful in determining changes since the factors affecting their distribution are well known. Substrate type is

paramount in determining the composition of the benthic community of a given area. Salinity fluctuations and range, wave shock and tidal exposure follow in importance. The structure of a community and how it changes through time are important determinants in assessing impacts from various stresses. The successional state of the macroinfauna can range from azoic, pioneering, intermediate, to climax communities. Pioneering communities are dominated by smaller organisms with little ability to burrow more than a few millimeters into the substrate. The taxa are typically dominated by deposit feeding organisms with sucking types of feeding apparatus. "Climax" communities are dominated by larger invertebrates that are adapted to deep burrowing activities. The taxa contain many larger "top-down" feeders and a large variety of predatory type organisms. Shallow areas which are controlled by physical events, such as storms and waves are typically populated only by pioneering communities whereas deep areas in which physical disturbance is not a controlling factor are typically populated by intermediate and climax communities.

4.11.2.1 Benthic Invertebrates Alternative A - No Action

Maintaining the Pascagoula Harbor Lower Pascagoula and Bayou Casotte Channels at its current authorized project dimensions (i.e. dredging and subsequent placement) would not change the existing conditions in the benthic invertebrate community in Mississippi Sound around the Pascagoula area. Maintenance activities typically occur approximately every 18 months in the Lower Pascagoula Channel and every 12 months in the Bayou Casotte Channel. Incidental loss of the benthic community would continue to occur with maintenance dredging and placement activities. However, Mississippi Sound is a shallow, dynamic system and the sediment distribution is mostly controlled by the physical events within the area, such as storms and waves. The USACE, Mobile District has conducted several studies in Mississippi Sound demonstrating changing sediment distributions. Typical benthic communities existing within the Sound are those pioneering species adaptable to change and are high in abundance. The O&M dredging and placement operations would result in the unavoidable loss of some benthic invertebrates but those pioneering species adjacent to the impacted area would re-colonize within 2 to 3 months. Furthermore, these impacts would be temporary and similar to those of the Proposed Action.

4.11.2.2 Benthic Invertebrates - Proposed Action (Alternative 11)

The Preferred Alternative would result in permanent conversion of 87.6 acres of shallow, primarily silty clay soft bottom habitats to deeper habitat. It would alter the benthic habitat through dredging and placement activities. Potential impacts could occur from dredging and placement of the material. Dredging to widen the Pascagoula Harbor Lower Pascagoula and Bayou Casotte Channels with the subsequent placement of that dredged material and future O&M of that improved navigational feature would cause a temporary disruption to the benthic community located in and along the channel, in adjacent areas planned for channel expansion, and in locations selected for dredged material placement. Both infauna and epifauna invertebrates would be displaced and possibly destroyed. Studies on recolonization of the channel substrate vary depending upon the nature of the substrate (Chessa et al., 2007; Newell et al., 2004, and Bemvenuti et al., 2005).

Each of these studies evaluated the changes in the benthic community associated with dredging activities. All studies concluded there is an initial reduction in the species biomass, composition, and abundance. However, depending upon the habitat conditions, all studies report a recovery of species abundance, diversity, and biomass. Recovery of species abundance and diversity is 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 there is little evidence of impact on the community structure outside of the immediate dredging boundaries. In another study evaluating dredging on soft

bottom sediments, 7 months after dredging, the benthic communities were largely re-established (Chessa et al., 2007).

The benthic community also would experience impacts from placement of dredged material during the improvements and future O&M activities. Recovery of the community could range from a few months to several years (Bolam and Rees, 2003; USACE, 1999). A number of studies have evaluated the effects of dredging activities on biological resources. The ecological effects of maintenance dredging along the Gulfport Harbor Shipping Channel were investigated as part of a 1975 USACE study. The study included an evaluation of benthic invertebrates in dredge and placement areas over a 40 square mile grid centered on the Gulfport Harbor Navigation Channel. Samples were collected before and after dredging activities. An increase in the benthic community density and diversity above pre-dredge levels was observed at all stations in the 4 to 6 months following dredging. However, the increase was attributed to seasonal variation which masked any minor effects of the dredging activities. No significant or lasting effects were observed in samples taken before or after dredging and placement of dredged material (USACE, 1975).

USACE placement sites in the northeastern U.S. have been monitored since 1977 as part of the Disposal Area Monitoring System program. Disposal mounds analyzed in that program showed rapid recovery of species diversity and density within 3 to 6 months following placement of material (USACE, 1978; USACE, 1983; USACE, 1993). However, the composition of the benthic community shifted initially to more opportunistic species. Within 2 to 5 years, the benthic communities at disposal mounds were typically similar to those in undisturbed areas (USACE, 1993). In an evaluation of recolonization studies conducted in the eastern U.S., the marine benthos was observed to experience a decrease in the number of species, densities, and biomass with a subsequent rapid recovery (Bolam and Rees, 2003). Therefore, although a change in the health of populations, community structure and composition, trophic structure, or system function may occur, these impacts are temporary and typically the recovery time, in most cases, ranges from a few months to slightly more than 1 year.

It is reasonable to anticipate some non-motile and motile invertebrate species within the impacted area as identified in Table 4.2.1.2-1 will be destroyed by the improvements and future O&M operations; however, past studies associated with Mobile and Gulfport Harbors have routinely demonstrated benthos recover within a few months. For placement sites, dredged material is distributed throughout the site to minimize impacts to the benthos. Those open-water areas would likely have motile benthic, which would be able to avoid the disturbed area and return shortly after the activity is completed. Minor increases in turbidity are anticipated during the operations within the Mississippi Sound; however, data collected during past O&M operations in the Sound indicate that the suspended solids generated typically settle out in a short amount of time and do not result in significant long-term increases in turbidity. Any impacts on the benthic community would be less than significant.

4.11.2.3 Benthic Invertebrates Alternative (All Others)

The other alternatives would result in permanent conversion of up to 116 acres of shallow, primarily silty clay soft bottom habitats to deeper, hypoxic habitat which resulting in an alteration of the benthic habitat through dredging and placement activities to varying degrees. Dredging to widen the Pascagoula Harbor Lower Pascagoula and Bayou Casotte Channels with the subsequent placement of that dredged material and future O&M of that improved navigational feature would cause a temporary disruption to the benthic community located in and along the channel, in adjacent areas planned for channel expansion, and in locations selected for dredged material placement to varying degrees. These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.3 Fish

4.11.3.1 Fish Alternative A - No Action

Impacts to the fish community in Mississippi Sound would be limited to temporary displacement from the continued O&M activities typically occurring within Pascagoula Harbor every 12 to 18 months. There also could be minor incidental mortality from activities, but no species would be threatened with local extinction. There would be no change to the habitat available to the fish community as it currently continues to co-exist with the ongoing routine O&M activities, and the community structure would remain the same. Any impacts would be temporary and minor in nature.

4.11.3.2 Fish - Proposed Action (Alternative 11)

Widening Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channels 100-foot to the west and the subsequent placement of dredged material within the Pascagoula ODMDS and/or LZPA would result in temporary disruption to the mature fish community in the vicinity of the Proposed Action. Dredging and disposal of the dredged materials could cause behavioral impairment (e.g., disruption of migration patterns), physical impairment (e.g., turbidity-induced clogged gills resulting in suffocation, or abrasion of sensitive epithelial tissue), and potentially acute and chronic effects (e.g., growth, reproduction, and behavior) related to exposure to elevated concentrations of suspended sediment (Newcombe and Jensen, 1996). Sediment testing conducted by the USACE, Mobile District in 2010 evaluated the physical, chemical and biological parameters of that proposed new work material and the subsequent O&M material. The USACE, Mobile District's evaluation found the material was suitable for placement within the designated disposal sites. Placement sites would continue to be used for placement of suitable dredged material; therefore, acute and chronic effects to aquatic organisms related to chemical contaminants would not occur. Any potential effects to finfish and shellfish associated with disposal activities would largely be related to contact with turbidity plumes (disposal-induced elevated concentrations of TSS). Although water column turbidity would increase in open-water habitats during dredging and placement activities, such effects would be temporary and local. Un-impacted fish would return after operations cease. Direct impacts to mature fish would be minimal and less than significant.

Demersal or low mobility biota, or biota with demersal or low mobility life stages could be impacted through direct burial during placement of dredged sediment. This could include ichthyoplankton suspended in the water column, nekton, or newly settled larvae in the benthos. Egg, embryonic, and larval stages of finfish are most susceptible to mortality and injury (Blaxter, 1969, 1974; McGurk, 1986; Black et al., 1988; Chambers et al., 1988). Some incidental loss could occur during dredging and placement operations; 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 less than significant. Indirect impacts to the food web may occur as a result of the dredging operations. In a recent study, changes in the benthic community were assessed to determine the effects a change in community structure would have 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) offers an enhanced trophic structure for the fish community (Bolam and Rees, 2003). Any impacts would be less than significant.

4.11.3.3 Fish Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.4 Mollusks

4.11.4.1 Mollusks Alternative A- No Action

No change in the existing mollusk community would result from the No Action Alternative. Maintaining the channel at existing authorized dimensions would continue to cause impacts similar to those of the Proposed Action. Those impacts would be temporary and minor.

4.11.4.2 Mollusks - Proposed Action (Alternative 11)

Dredging 38,549 feet (~7.2 miles) in length to widen 100-foot to the west of Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channels and subsequently placing the dredged material within the Pascagoula ODMDS and/or the LZPA would result in temporary disruption to the mollusk community. Bivalves and semi-sessile mollusks could be displaced by dredging and placement operations. However, bivalves (through larval recruitment) would re-colonize the area and in past studies the benthic assemblage was similar to pre-dredging conditions within 9 months (Bolam and Rees, 2003). There would likely be some incidental loss of semi-sessile mollusks during disposal operations; however, these would represent a very limited portion of the population, which would ultimately repopulate the new substrata. Re-colonization of the disposal site would occur from those individuals located at the boundary of the disposal site or through larval recruitment. The channel and nearby areas have not been identified as habitat for oysters; therefore, the Proposed Action would have less than significant impacts on these sessile organisms. Any impacts to mollusks would be temporary and minor.

4.11.4.3 Mollusks Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.5 Crustaceans

4.11.5.1 Crustaceans Alternative A - No Action

Impacts to crustaceans in Mississippi Sound would be limited to temporary displacement and minor incidental mortality resulting from maintenance activities. No species would be threatened with local extinction from these activities. The crustaceans in Mississippi Sound in the vicinity of the Pascagoula Harbor Navigation Channel would experience temporary minor impacts from the No Action Alternative and recovery and re-colonization would be expected. There would be no permanent change to the habitat available to the crustaceans, and the community structure would remain the same.

4.11.5.2 Crustaceans - Proposed Action (Alternative 11)

Dredging approximately 38,549 feet (~7.2 miles) in length to widen 100-foot to the west of Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channels and subsequently placing the dredged material within the Pascagoula ODMDS and/or the LZPA, would create a temporary disruption to the mature crustaceans in the vicinity of the Proposed Action. The primary crustaceans found in the area are shrimp, crabs, and amphipods. The crabs and shrimp are fairly mobile and during dredging or disposal operations could avoid impact, although there would be some mortality and displacement. Most of these organisms would likely leave the area during dredging and placement activities and return after operations cease. Juvenile crustaceans, such as shrimp, are not free-swimming and rely on currents to carry them in-shore to estuarine nurseries. There would likely be some incidental loss of juvenile crustaceans during dredging and placement operations, however,

these would represent a very limited portion of the population, and not have long-term adverse effects on the crustacean community. Amphipods are infauna and live in the bottom sediments. These species would experience mortality from both dredging and placement of sediments. As reported by Bolam and Rees (2003), the total abundance and community structure had decreased. However, recovery for both the dredging and placement sites was well underway within 3 months. Future O&M impacts to crustaceans of that improved navigation channel would be similar to those described in Section 4.11.5.1. Any impacts would be less than significant.

4.11.5.3 Crustaceans Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.6 Hard Bottom

The significance criterion for hard bottom habitats would be the permanent loss of hard bottom habitat. No hard bottom habitat is known from the location of the project area; therefore, no impacts are anticipated to hard bottoms for any of the alternatives.

4.11.7 Submerged Aquatic Vegetation

The significance criterion for SAV would be the permanent loss of habitat suitable for SAV. Vegetation communities that occur in the proposed project area are almost exclusively estuarine and marine deepwater and wetland habitats: less than one percent of the project area includes freshwater wetlands. The estuarine and marine habitats in Mississippi Sound in the vicinity of the proposed project include habitats associated with open water, the LZPA and the Pascagoula ODMDS sites, such as natural and anthropogenic islands, barrier beaches and SAV.

4.11.7.1 SAV Alternative A - No Action

No change in existing conditions would occur under the No Action Alternative. There is no SAV at any of the locations that would be used for placement of material removed through maintenance dredging. Therefore, placement of dredged material would not impact SAV.

4.11.7.2 SAV - Proposed Action (Alternative 11)

Approximately 652 acres of SAVs occur near the study area on the north shorelines of the barrier islands. No SAVs are known to occur within the proposed dredging and placement footprint of this proposed project. A 2005 report of seagrass distribution in the barrier islands of Mississippi was prepared for the MDMR. This report indicated that in 2003, approximately 902.6 acres of seagrasses existed in the Mississippi Sound. Cat Island had the largest seagrass area, with 507.6 acres. Horn Island had 246.7 acres, Petit Bois Island had 131.3 acres and Ship Island had 16.9 acres (MDMR, 2005).The closest SAVs identified in the 2009 surveys were approximately 1 mile to the east near Petit Bois Island. Algae was identified in disposal area 10 (now called the LZPA) in 1992 and a 1999 survey did not identify any SAV in that disposal area. The origin of dredged material placed in disposal area 10 would be from the Horn Island Pass. The material in this area consists of sand and silty sand, which represents more than 80 percent of the material. This material, along with shell fragments, is suitable for a variety of vegetation (Eleuterius, 1973). The long-term benefit of replenishing the sediments and maintaining suitable water column depths within the littoral drift area would help support SAV. Any negative impacts from placement of dredged material would be temporary and minor, while long-term

impacts from sediment replenishment would be beneficial. No direct impacts associated with construction and future O&M operations are anticipated. Impacts are considered less than significant.

4.11.7.3 SAV Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.8 Marine Mammal Communities

The significance criteria for marine mammal communities in the vicinity of the Pascagoula Harbor Lower Pascagoula and Bayou Casotte Navigation Channels would be a localized loss of a species; a permanent habitat change that would make the area unsuitable to meet life history requirements; or a disruption that would cause permanent interference with the movement of native resident or migratory marine mammals.

4.11.8.1 Marine Mammal Communities Alternative A - No Action

Under the No Action Alternative, no change from existing conditions would occur and noise impacts have been previously addressed in Section 4.6. Marine mammals, such as bottlenose dolphins and West Indian manatees, co-exist with current operations. In fact, Mississippi Sound has been noted for its viable bottlenose dolphin population. All impacts to marine mammals would be less than significant.

4.11.8.2 Marine Mammal Communities - Proposed Action (Alternative 11)

Section 4.6 addressed noise impacts to marine mammals. As defined by the MMPA, dredging operations could result in harassment of marine mammal species if the mammals are in close proximity to an operating dredge. However, this would be a temporary condition and the mammals can swim around the noise and vessel disturbance. Water depth and bottom type also affect the propagation of sound energy. Analysis of sound propagation in shallow waters indicates lower frequencies at which there is no sound propagation. However higher frequency noise has the potential to propagate and may cause temporary avoidance near the dredging operations. These levels are not known to cause any injury, temporary or permanent, to marine life, and would not remain in any single location for longer than a few days. These conditions would eliminate propagation for a substantial portion of the noise generated by dredging operations associated with the Proposed Action Alternative.

Response to noise is also influenced by the species that would be exposed to project-related noise. Whales known to occur in the Gulf of Mexico include finback and humpback whales. These whales hear best at frequencies between 80,000 and 150,000 Hz. Because the highest frequency associated with dredging noise is about 1,000 Hz, it is unlikely that that these whales would be disturbed by the Proposed Action Alternative. Considering the limits on propagation of underwater noise for shallow water depths and soft bottom conditions within the project area, the tendency of marine species to avoid anthropogenic noise, and previous exposure to maintenance dredging activities, any noise impacts from the Proposed Action are expected to be minor and would be less than significant.

4.11.8.3 Marine Mammal Communities Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.9 Marine and Coastal Birds Communities

4.11.9.1 Marine and Coastal Birds Communities - Alternative A - No Action

Under the No Action Alternative, minimal impacts would occur during existing conditions of on-going dredging and placement activities as previously addressed in Section 4.6. It is typical that these birds frequent the placement areas due to the potential food sources. This is a temporary disturbance and some will avoid the area regardless. Every effort is made to avoid applicable areas during nesting season.

4.11.9.2 Marine and Coastal Birds Communities - Proposed Action (Alternative 11)

Marine and coastal birds are common in the area and could utilize the site of the Proposed Action Alternative for foraging and adjacent islands for nesting, roosting, or stopovers during migration. Foraging birds could be displaced during dredging and placement activities. The noise and activity of dredging and placement operations could deter birds from using areas in the immediate vicinity of equipment during active periods but could also offer an additional food source. Increased turbidity associated with dredging operations could temporarily decrease foraging success of diving and plunging birds that feed in deepwater areas, however, these birds are not dependent upon the dredge and placement sites for survival. Foraging habitat is readily available in the northern Gulf and Mississippi Sound and it is expected that plunging and diving birds would shift to other areas if temporarily displaced. Following dredging, birds would be expected to resume normal use of the area. Any impacts would be expected to be localized, temporary, and minor.

Protected bird species, as listed by the State of Mississippi, anticipated to be within an affected range from the project area include: the piping plover (*Charadrius melodus*), Mississippi sandhill crane, bald eagle (*Haliaeetus leucocephalus*), and brown pelican (*Pelecanus occidentalis*). Bird species preferring nearshore habitat include the bald eagle, brown pelican, least tern, Mississippi sandhill crane, white ibis, peregrine falcon, black-crowned night-heron, and gray kingbird. Because the dredging and placement equipment would only be operating in the project study area for a short time in any given segment of the channel, effects on any of the eight nearshore birds' foraging or nesting habits would be temporary and minor.

Bird species preferring offshore habitat include the piping plover, reddish egret, royal tern, and gull-billed tern. The shipping channel extends between Horn Island and Petit Bois Island, both of which have been designated critical habitat for the wintering piping plover. Even with the historic and existing high levels of shipping traffic and ongoing maintenance dredging, the piping plover continues to winter on the two islands, which suggests that the Proposed Action Alternative would have a minor impact on this species. Direct impacts to the designated critical habitat would not be expected, as dredging operations would not encroach upon coastal beach areas or either of the islands. In addition, because of the distance between the beach habitats of the barrier islands and the Proposed Action Alternative, effects on foraging and nesting habits for any of the four sensitive offshore birds would be expected to be temporary and minor.

The Proposed Action could disrupt resident birds and breeding migrants (e.g., black skimmers, gulls, pelicans, terns, osprey, and heron) on barrier islands. The eastern end of Horn Island is 3.2 miles and the western end of Petit Bois Island is about 0.7 miles from the nearest proposed work area and any impacts would be minor. Both islands are outside of the typical state and federal buffer zones of 300 feet for nesting shorebirds. In addition, placement of dredged material would occur in nearshore areas and not directly on the barrier islands. Birds may temporarily avoid the end of the island nearest the work area, which could temporarily impact nesting and roosting behavior. Impacts would be less than significant.

Migratory birds using the barrier islands as a stopover point normally arrive with low body reserves of fat. Disturbance from dredging could cause some migrants to avoid the western portion of Petit Bois Island. These migrants would likely seek other nearby areas not affected by the dredging. The peak numbers of migrants occur from mid-April through early May and early September through mid-October (Moore et al., 1990).

All impacts would be less than significant.

4.11.9.3 Marine Mammal Communities Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.11.10 Threatened & Endangered Species

Potential impacts to federally listed T&E species were evaluated for each of the alternatives. The significance criteria for T&E species would be:

- Loss of or long-term reduction in a population.
- Habitat modification that causes a permanent disruption to breeding, foraging, or other life history requirements.
- Permanent interference with the movement of native resident or migratory protected species.
- Loss of any areas designated as critical habitat.
- Incidental take and non-lethal take exceed the identified allotment during Section 7 consultation for sea turtles and Gulf sturgeon.

4.11.10.1 Threatened & Endangered Species Alternative A - No Action

Under the No Action Alternative of continuing to maintain the existing navigation channel with the present dimensions via maintenance dredging and placement activities, no permanent or long-term impacts to protected species would result. Any disturbances in foraging would be minimal and following the completion of dredging activities, any displaced animals would be expected to resume normal use of the area. Maintenance dredging would comply with the GRBO for sea turtles and Gulf sturgeon and annual allotted incidental takes would be limited as specified in the GRBO.

4.11.10.2 Threatened & Endangered Species - Proposed Action (Alternative 11)

The majority of impacts to T&E species anticipated as a result of the Proposed Action Alternative would be temporary in nature. Potential temporary and permanent impacts are described in general below and then discussed with respect to potentially impacted species.

Temporary impacts include:

- Underwater noise caused by dredging and placement activities during construction and future maintenance dredging.
- Changes to water quality, such as elevated turbidity levels and potential release of contaminants in sediments.
- Changes to predator prey dynamics for benthic feeders (disruption of foraging habitat).

Permanent impacts include:

- Changes in water quality and bottom (potential water column stratification resulting in hypoxic conditions).
- Potential ship strikes.
- Increased competition from invasive species being carried in ballast water.

Mammals

The whale species listed as T&E that could occur in the vicinity of the study area include finback, humpback, blue, sei, and sperm whales and typically occur in the deeper waters off the continental shelf. These species would only venture through the study area as incidental transients. Any impacts to these species would be limited to annoyance and alteration of swimming patterns to avoid the active dredging areas. Following the completion of new work and future O&M dredging and placement activities, any displaced animals would be expected to resume normal use of the area. However, it is anticipated that no whales would likely venture into the project area.

The West Indian manatee is known to migrate through the project study area between Florida and Louisiana. Active dredging and placement may cause these animals to alter their route, but would not prevent their passage across the project study area. Impacts to the manatee would be less than significant. Any impacts to these species would be limited to annoyance and alteration of swimming patterns to avoid the active dredging areas. Following the completion of dredging activities, any displaced animals would be expected to resume normal use of the area. Any such impacts would be less than significant.

Birds

The red-cockaded woodpecker would not be impacted by the proposed dredging and placement actions because it is not found in the open water environment.

The Mississippi Sandhill Crane prefers a fire-maintained open savannah environment and would not be affected by proposed dredging and placement actions.

Threatened & Endangered bird species anticipated to be within an affected range from the project area include the piping plover (*Charadrius melodus), red knot (Calidris canutus rufa)* and the bald eagle (*Haliaeetus leucocephalus)* (bald eagle technically not protected under the ESA, but is protected under the Bald and Golden Eagle Protection Act). Since the dredging and placement equipment would only be operating in the project study area for a short time in any given segment of the channel, effects on any of the nearshore birds' foraging or nesting habits would be temporary and minor. The shipping channel extends between Horn Island and Petit Bois Island, both of which have been designated as critical habitat for the wintering piping plover. Even with the historic and existing high levels of shipping traffic and ongoing maintenance dredging, the piping plover continues to winter on the two islands, which suggests that the Proposed Action Alternative would have a minor impact on this species. Direct impacts to the designated critical habitat would not be expected, as dredging operations would not encroach upon coastal beach areas or either of the islands. Nesting season would be avoided if at all possible. Further ESA Consultation would be initiated with USFWS if necessary. In addition, due to

the distance between the barrier island beach habitats and the Proposed Action Alternative location, effects on foraging and nesting habitats for any of the T & E bird species would be expected to be temporary and minor. Critical Habitat has not been established for Red knot, and USFWS has indicated that further coordination would not be required due to recent listing of the Red knot.

Amphibians and Reptiles

The loggerhead, green, leatherback, hawksbill, and Kemp's ridley sea turtles may occur in the project study area. The immediate project study area is not a major provider of critical life history requirements for any of these species and any interaction between activities and the turtles would be rare. Following the completion of dredging and placement activities, any displaced animals would be expected to resume normal use of the area. The existing GRBO and its amendments on hopper dredging in the U.S. South Atlantic and Gulf of Mexico waters [most recently, January 9, 2007, GRBO to the USACE's four Gulf of Mexico districts' Biological Assessments (BAs)] have established that non-hopper type dredging methods have discountable effects on, or are not likely to adversely affect, currently listed sea turtles (I/SER/2006/02953; I/SER/2006/01096). Incidental take may result from entrainment by hopper dredging equipment, but this is unlikely for adult sea turtles. Anticipated impacts to adult sea turtles would be temporary and minor. Late juvenile life history stages of sea turtles are benthic and could be captured or entrained by dredging equipment (USACE, 1990b). As a result, the NMFS issued a GRBO in 2003 for hopper dredging impacts on sea turtles. The NMFS has determined that associated future maintenance of the improved Federal channel would fall within the incidental take statement issued under the GRBO. The GRBO and subsequent updates in 2005 and 2007, and USACE Management Protocol require that USACE comply with the following terms and conditions:

- Annual incidental take for USACE conducted hopper dredging in Mobile District include: 3 Kemp's Ridley, 2 green, 0 hawksbill, and 4 loggerhead sea turtles.

- Use of relocation trawlers under specific conditions to minimize turtle interactions.

- NOAA Fisheries-approved observers monitoring the hopper dredged material, screening, and dragheads.

- Screening of 100 percent of dredged material with 4-inch by 4-inch screen.

- Dredging pumps disengaged by the operator when the dragheads are not on the bottom.

- Use of sea turtle deflecting dragheads on all hopper dredges in all Gulf of Mexico channels.

NFMS requests that the Districts schedule hopper dredging operations between December 1 and March 31 whenever feasible. Because dredging and placement activities would be done in compliance with the NMFS' GRBO and NMFS' reasonable and prudent measures provided in their Biological Opinion, any impacts would be less than significant (*Appendix C – Agency Correspondence*). In July 2014, the USFWS designated approximately 685 miles of coastal beach habitat as important for the recovery of the threatened Northwest Atlantic Ocean population of loggerhead sea turtles, as directed by the ESA. The terrestrial critical habitat areas include 88 nesting beaches in coastal counties located in North Carolina, South Carolina, Georgia, Florida, Alabama, and Mississippi. These beaches account for 48 percent of an estimated 1,531 miles of coastal beach shoreline and about 84 percent of the documented nesting within these six states. Areas designated as critical habitat in Mississippi nearest the project area include Horn Island and Petit Bois Island. However the proposed action does not include impacting these areas, and USFWS has stated no further coordination actions would be required.

The Alabama red-bellied turtle may occur in the project study area but would likely be found further north in the Pascagoula River's freshwater. The Alabama red-bellied turtles are highly mobile and would likely avoid the area due to the project area's salinity, activity and noise. Normal behavior patterns of 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 the turtles to avoid the immediate area. Furthermore, the Proposed Action would not adversely impact existing aquatic vegetation or the adjacent river banks that may be utilized by the species.

Aquatic and terrestrial habitats that support the yellow-blotched map turtle, eastern indigo snake, Gulf salt marsh snake, gopher tortoise, and Mississippi gopher frog are found outside of the proposed dredge areas and are beyond the range of impacts of the proposed action and would have no effect on this species.

The Mississippi diamondback terrapin may occur in the project study area. This species is a resident of coastal salt marshes, estuaries, and tidal creeks. Its primary associated habitat is coastal salt marshes, but is also located on offshore sandy islands or on extensive tidal mudflats. Because the dredging and placement equipment would only be operating in the project study area for a short time in any given segment of the channel and would only occur in open water, the Proposed Action would not adversely impact the Mississippi diamondback terrapin.

Fish

The pearl darter is known to occur in the Pascagoula River upstream and not within the study area. The Gulf sturgeon migrates through the Mississippi Sound and may occur in the Sound at any time. The Gulf sturgeon feeds on the bottom and could be captured or entrained by hopper dredging equipment. Temporary displacement may result from the disturbance of dredging and placement activities. Gulf sturgeon occur regularly in the project study area, but the impacts would be expected to be limited to incidental contact during foraging and subsequent avoidance of active work areas. Following the completion of dredging and placement activities, any displaced fish species would be expected to resume normal use of the area. Incidental mortality could result from entrainment by hopper dredging equipment, but would not result in large population reductions. The GRBO terms and conditions for hopper dredging and relocation trawling limit the incidental take of Gulf sturgeon in the Mobile District to two sturgeon from hopper dredging and eight sturgeon from relocation trawling. Because work would comply with the GRBO, only minor temporary impacts to Gulf sturgeon would be expected and the impacts would be less than significant.

4.11.10.3 Threatened & Endangered Species Alternative (All Others)

Similar impacts would be anticipated from the other alternatives since the project area is located within the same channel but only varying in widths and operations would utilize the same equipment and placement disposal sites. These alternative(s) would result in impacts that would be less than significant.

4.12 Water Quality

The significance criteria for water quality in the vicinity of the Pascagoula Harbor Lower Pascagoula and Bayou Casotte Navigation Channels would be a permanent change in water quality from organic and inorganic chemicals; 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.

Disposal of dredged sediments in U.S. waters is allowed provided there is avoidance of "unacceptable effects," compliance with applicable water quality standards after considering dispersion and dilution, toxic effluent standards, and marine sanctuary requirements, and no jeopardy to endangered species (Section 404 Federal Water Pollution Control Act [Pub. L. 92-500]). Therefore violation of any of these standards is considered an adverse impact to water quality. Potential impacts of water quality constituents of concern, specifically salinity, DO, TSS, nutrients, bacteria, and various metals and pesticides, are addressed here.

ERDC's water quality model study of the Mississippi Sound has been previously discussed in detail earlier in this EIS and the entire report(s) are included in Appendix B. The focus of the water quality effort of this study was to understand the existing water quality within Mississippi Sound and to quantify the relative changes in the water quality and flushing capacity resulting from the proposed action and other alternatives in the area of Bayou Casotte. Overall, comparison of results from the East Widening and West Widening runs showed slight changes in circulation but caused minor effects to water quality concentrations in the area of modifications. Both scenarios showed similar impacts to water quality. However, it is concluded from these results that none of the modifications simulated would have detrimental water quality impacts. Although water quality changes were noted, all were within the state standard for constituents of interest for ocean waters. Water column turbidity would be temporarily affected during dredging and placement activities at localized areas. The generation of turbidity from routine O&M dredging is often a concern since turbidity increases as a result of these activities and can reduce light penetration through the water column, thereby reducing photosynthesis, surface water temperatures, and aesthetics in the vicinity. These conditions can also potentially alter visual predator-prey relations and result in respiratory stresses in fish.

Mississippi has established water quality goals, known as water quality standards, which protect aquatic life and allow for safe use by the public. In order to ensure water quality is not significantly degraded, the State reviews the pertinent data and grants State Water Quality Certification if the data are acceptable. Since there are no suitable management practices, methods, or technologies available that provide the capability to control turbidity levels during dredging and placement in Mississippi Sound, a mixing zone is often granted by the State, typically for dredging of Federal navigation projects in Mississippi Sound. Turbidity outside the limits of a 750-foot mixing zone shall not exceed the ambient turbidity by more than 50 NTUs. A review of the turbidity compliance samples taken for historical dredging events in Mississippi Sound at distances no greater than 750-feet down-current of dredging and open-water placement activities have shown no violations of the State's water quality standards.

The water quality monitoring indicates changes in the channel leading to Bayou Casotte would have little effect to overall water quality in and around the project and also some distance from the project. The fate of these pollutants is affected by currents, flows, and other physical and chemical factors, all of which are directly addressed in Sections 2.2.2, Bathymetry, and 2.2.4, Hydrodynamics.

4.12.1 Salinity

Observed and model data show trends of lower salinity values in the spring increasing to higher values in the summer period. Spring rains keep salinity levels along the coastline low and as summer approaches, salinity levels rise.

4.12.1.1 Salinity Alternative A - No Action

Under the No Action Alternative, there would be no change from existing water quality salinity conditions. Maintenance dredging activities would produce water quality effects similar to those existing O&M operations.

4.12.1.2 Salinity - Proposed Action (Alternative 11)

The proposed channel will be larger than the existing channel, thereby increasing the volume of saltwater entering Bayou Casotte from the Gulf and potentially reducing the dilution effect of the freshwater from Bayou Casotte on salinity in Mississippi Sound. Effects of altered salinity gradients may be most evident among the early life history stages of both invertebrates and fish, which can be particularly sensitive to salinity alterations (i.e., James et al. 2003, Kefford et al. 2007). Deepening an estuarine channel can alter the degree and form of estuarine mixing as the extent of mixing of fresh waters and salt waters in estuaries is dependent, in part, on channel bathymetry, fluvial and tidal energy, substrate roughness, and other lesser factors (USACE 2009a).

Waters in this portion of the Mississippi Sound are stratified, i.e., lower density freshwater flows across the top of higher density saline waters at the bottom of the channel, and fresh and salt water mix only in a transition zone and the vertical stratification important to local biota is maintained. Salinity would be affected as a result of water column mixing during dredging and placement activities. Profiles would return to previous conditions following completion of dredging. Any impacts to profiles would be temporary and minor. Bottom salinity in the vicinity of the channel could increase following channel widening, but any changes would be expected to be minor because the majority of the channel has been improved previously. Therefore, no adverse impacts in the freshwater-saltwater mixing zone in this stratified system are anticipated.

Water quality modeling indicated channel widening leading to Bayou Casotte would have minimal impact. Water quality monitoring showed changes in salinity indicating circulation changes but were considered insignificant. The largest maximum percent change in salinity was around 14 percent and occurred at station 13 where values went from ≈15.0 ppt (“Existing” conditions) to 16.8 ppt (“West Widening” conditions). This station was located west of Bayou Casotte. As with the other constituents, all stations showed changes in salinity which indicated circulation changes, but were considered insignificant.

4.12.1.3 Salinity – Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.12.2 Temperature

Temperatures in both deep and shallow water correspond to seasonal variations in air temperature, with higher temperatures in summer months and lower temperatures in cooler months (Thompson et al., 1999).

4.12.2.1 Temperature Alternative A - No Action

Temporary and minor effects on temperature profiles are expected during the O&M dredging operations and for a short period of time after dredging operations have been completed due to water column mixing.

4.12.2.2 Temperature - Proposed Action (Alternative 11)

Temperature profiles would be affected as a result of water column mixing during dredging and placement activities. Temporary and minor effects on temperature profiles are expected during the dredging operations and for a short period of time after dredging operations have been completed due to water column mixing. Profiles would return to previous conditions following completion of dredging. Any impacts to profiles would be temporary and minor.

4.12.2.3 Temperature – Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.12.3 Dissolved Oxygen

Changes in DO could occur due to mixing and release of sediments into the water column during dredging and dredged material placement.

4.12.3.1 Dissolved Oxygen Alternative A - No Action

The No Action would result in no change from existing temperature conditions. Continued maintenance dredging activities would produce water quality effects similar to those of the Proposed Action.

4.12.3.2 Dissolved Oxygen - Proposed Action (Alternative 11)

State standards for DO are that a daily average from a sample location should not fall below 5.0 mg/L, and that instantaneous readings should not fall below 4.0 mg/L. Additionally, it is recommended that the measurement depth be determined based on where stratification layers (whether from temperature or salinity) exists. For those coastal waters which are stratified, DO measurements should be collected when possible from the mid-depth of the epilimnion if the epilimnion depth is 10 feet or less or at 5 feet from the water surface if the epilimnion depth is greater than 10 feet. Based upon these guidelines, the MDEQ criteria do not require DO measurements from the bottom waters, in part because existing guidance is to measure DO levels in the water mass of stratified water bodies (the surface layer) where DO levels would be highest, while not sampling in the water mass (the bottom layer) where problematic levels of DO most commonly occur. Effects on DO levels in shallow waters are for the most part expected to be minor and temporary. DO concentrations could decrease during and immediately following dredging due to the movement of anoxic water and sediments through the water column. DO could also be affected by short-term increases in organic material and associated aerobic decomposition. Temporary effects of the dredging operations will be limited to the mixing of water with bottom sediments, resulting in increased chemical and biological oxygen demand. Any impacts would be expected to be restricted to the immediate vicinity of the dredging and dredged material placement areas. Once activities cease and disturbed material settles, DO concentrations would return to pre-disturbance levels. Any impacts would be temporary and minor. Although decreases in DO concentrations occurred, the largest decrease was considered insignificant and well within state standards in ocean waters. In the ERDC Water Quality Monitoring Report, DO concentrations are reduced by approximately 6 percent for both widening scenarios. In other words this translates into a change of DO concentration from ≈7.75 to 7.29 mg/L.

4.12.3.3 Dissolved Oxygen Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.12.4 Hypoxia

The significance criteria for hypoxia in the vicinity of the project study area would be a permanent change in hypoxic conditions or a temporary change 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).

4.12.4.1 Hypoxia Alternative A - No Action

The No Action alternative would result in similar conditions to existing water quality conditions. Continued maintenance dredging activities would produce water quality effects similar to those that

currently exist. Past observations have shown that hypoxic conditions have not been observed at sampling stations in Mississippi Sound near the Bayou Casotte Channel.

4.12.4.2 Hypoxia - Proposed Action (Alternative 11)

The Proposed Action would result in short-term impacts and would not significantly degrade water quality within the project study area. Concentrations of nutrients may increase locally for short periods following dredging and dredged material placement; however, currents and waves in the Mississippi Sound would quickly dilute material in the water column and not promote hypoxic conditions. Any impacts would be temporary and minor.

4.12.4.3 Hypoxia Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.13 Commercial and Recreational Fishing

The significance criteria for the commercial and recreational fishing in the vicinity of the project study area would be a permanent localized loss of a commercial or sport species or a change in the habitat structure in the area that would subsequently lead to a change in species composition and ultimately lead to long-term changes in revenue for fisheries in the Mississippi Sound.

4.13.1 Recreational Fish

4.13.1.1 Recreational Fish Alternative A - No Action

Future O&M activities would temporarily disrupt fish distribution and localized commercial and recreational fishing in the immediate vicinity of dredging and placement activities. However, once dredging operations were completed, the fish community would return to the area and commercial and recreational fishing activities would recover. In addition, during the dredging operations, fishing activities could be conducted at other locations in the Mississippi Sound. Use of the dredging and placement area would be expected to resume after work is complete. Any impacts to recreational fishing would be less than significant.

4.13.1.2 Recreational Fish - Proposed Action (Alternative 11)

Dredging the channel and subsequent placement activities, and future O&M activities, would temporarily disrupt fish distribution and localized commercial and recreational fishing in the immediate vicinity of dredging and placement activities. However, once dredging operations were completed, the fish community would return to the area and commercial and recreational fishing activities would recover. In addition, during the dredging operations, fishing activities could be conducted at other locations in the Mississippi Sound. Use of the dredging and placement area would be expected to resume after work is complete. Any impacts to recreational fishing would be less than significant.

4.13.1.3 Recreational Fish Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.13.2 Commercial Fishing - Shellfish – Shrimp, Crabs, and Oysters

4.13.2.1 Commercial Fishing - Shellfish - Shrimp, Crabs, and Oysters Alternative A - No Action

Dredging to remove regular maintenance of dredged material would temporarily disrupt shellfish distribution and localized commercial and recreational harvesting in the immediate vicinity of dredging and placement activities. Use of the dredging and placement area would be expected to resume after work is complete. No significant impacts to commercial and recreational fisheries would result.

4.13.2.2 Commercial Fishing - Shellfish - Shrimp, Crabs, and Oysters - Proposed Action (Alternative 11)

Dredging to widen the channel would temporarily disrupt shellfish distribution and localized commercial and recreational harvesting in the immediate vicinity of dredging and placement activities. However, once dredging operations were completed the shellfish community would reestablish in the area and commercial and recreational harvesting activities would recover. In addition, during the dredging operations, harvesting activities could be conducted at other locations in the Mississippi Sound. There are currently no managed or established shellfish beds in the proposed project area. Use of the dredging and placement area would be expected to resume after work is complete. Any impacts to shellfish would be less than significant.

4.13.2.3 Commercial Fishing - Shellfish - Shrimp, Crabs, and Oysters Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.14 Essential Fish Habitat

The significance criteria for the EFH in the vicinity of Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channels would be a permanent change or loss in the habitat designated as critical to fish species of concern in Mississippi Sound.

4.14.1 Essential Fish Habitat Alternative A - No Action

The No Action Alternative would likely not have significant negative effects to the EFH in Mississippi Sound in the project area. Continued maintenance dredging of the Bayou Casotte and Lower Pascagoula Channel(s) is a repetitive activity requiring dredging every 12-18 months. Maintenance dredging removes sediments from the navigation channel bed, which have been transported there naturally via longshore currents. The composition of dredged material removed from the channel is expected to be the same as that remaining. Dredging will impact epibenthic crustaceans and infaunal polychaetes within the navigation channel; however, the impacts are primarily short-term in nature and consist of a temporary loss of benthic invertebrate populations in the areas of dredging. The area will continue to support sub-littoral benthic biota and the benthic biota in the dredging areas will recover and recolonize. Non-motile benthic fauna within the area would be destroyed by placement operations, but should repopulate within 12 months of project completion (Culter and Mahadevan, 1982; Saloman et al., 1982). Motile benthic and pelagic fauna, such as crab, shrimp, and fish, are able to avoid the disturbed area and should return shortly after dredging is complete.

Studies of impacts of open-water disposal on benthic communities and fisheries resources have been undertaken nationwide for many years. Placement of materials similar to ambient sediments has been shown to produce less severe impacts to contrast the placement of dissimilar sediments. Pre- and post-monitoring of water quality suggest turbidity and TSS are temporarily affected by disposal operations. However, the magnitude of the increases with disposal operations is consistent with those caused by frontal storms. Studies on fisheries resources, adult, pre-adult and juvenile form, indicate that most species are able to avoid the area of disposal or are unaffected.

4.14.2 Essential Fish Habitat - Proposed Action (Alternative 11)

The managed species with sensitive life stages occurring within the Mississippi Sound water column (pelagic) and or substrate (demersal) include: red drum, brown shrimp, white shrimp and pink shrimp. The proposed dredging and dredge material placement would occur at depths shallower than those known to support spawning; therefore significant direct impacts to spawning red drum or shrimp populations or their eggs are unlikely. Although these species may occur within the maintenance material open-water placement sites they are documented as being more common and abundant near estuarine wetlands and/or shallow vegetated areas away from the proposed dredging and placement activities. Notwithstanding the potential harm to some individuals from direct burial, no significant impacts to populations of shrimp or red drum species are expected.

Direct effects caused by dredging and placement activities include behavioral impairment, physical impairment, and potential acute and chronic effects related to exposure to elevated concentrations of suspended sediment. Open-water disposal sites and the LZPA would continue to be used for disposal of clean maintenance dredged material; therefore, acute and chronic effects to aquatic organisms related to chemical contaminants would not occur. Any potential acute and chronic effects to finfish and shellfish associated with disposal activities would largely be related to contact with turbidity plumes. Although water column turbidity would increase in open-water habitats during dredging and placement activities, such effects are usually temporary and local.

Natural depths in the southern half of the Sound range from approximately –13 to –20 feet MLLW. South of Horn Island, natural depths range from approximately –20 to –45 feet MLLW in the vicinity of the ship channel. The widening of the existing channel would result in a permanent change in soft bottomed EFH from variable natural depths as shallow as -13 feet to a new depth of -42 feet plus 2 feet of advanced maintenance, 2 feet of overdepth dredging and 3 feet of sediment disturbance. Approximately 75.02 acres of shallow estuarine bottoms would be permanently deepened as a result of the proposed action. The total acreage of soft bottom EFH that could be temporarily affected by dredge material placement can be broken down as follows: open-water sites 3-9 total acreage is 7450 acres, LZPA is 1624 acres and the Pascagoula ODMDS is 20565 acres; however it should be noted that to date, approximately only 1/5 of each site has been utilized. Where feasible, the USACE employs thin-layer disposal techniques, where material is placed no more than 12 inches in thickness. Final depths post-disposal shall not be more than -4’ MLLW. Shoaling rates vary, however the Pascagoula Bar Channel, Horn Island Pass, Lower Pascagoula Channel and Bayou Casotte Channel are typically on an 18 month O & M dredging cycle.

Under most conditions, fish and other motile organisms are only exposed to localized suspended-sediment plumes for short durations (minutes to hours) (Clarke and Wilber, 2000). Turbidities exceeding 500 mg/L have been observed around maintenance dredging and placement operations. However, the maximum concentrations generally remain less than 500 mg/L and bottom suspended-sediment plumes are limited to within 500 m of the dredge (Havis, 1988; LaSalle, 1990). Pre- and post-monitoring of water quality at several open-water placement sites at Gulfport Harbor, Mississippi (1991 – 1992) following dredging suggests that TSS are only temporarily affected by disposal operations (USACE, 1999). In this study TSS were shown to be elevated in the bottom waters of the

disposal areas; suggesting rapid settling rates of the material or low wave and current energy unable to re-suspend the solids (USACE 1999).

The Mississippi Sound is a productive estuary with designated uses for recreation and fish and wildlife. These designations allow regulatory agencies to establish water quality goals, which protect aquatic life and allow for safe use by the public. These goals are referred to as Water Quality Standards. In order to ensure water quality is not significantly degraded, the State reviews and if found acceptable grants State Water Quality Certification. Since there are no suitable management practices, methods, or technologies available that provide the capability to control turbidity levels during dredging and placement in the Mississippi Sound, a mixing zone is often granted by the State, typically for dredging of Federal navigation projects in Mississippi Sound, a 50 Nephelometric Turbidity Units and a 750-foot mixing zone is granted. A review of the turbidity compliance samples taken at distances no greater than 750-feet down-current of dredging and open-water placement activities showed there were no violations of the State's water quality standards.

State regulatory restrictions along with continued turbidity monitoring would act in concert to ensure that dredging and disposal activities do not have significant effects on fisheries resources. Due to the relatively small area of ecosystem that would be affected (less than 1 percent of the Mississippi Sound) no significant long-term impacts are expected to occur.

Water quality monitoring showed changes in salinity indicating circulation changes but were considered insignificant. The largest maximum percent change in salinity was around 14 percent and occurred at station 13 where values went from ≈15.0 ppt ("Existing" conditions) to 16.8 ppt ("West Widening" conditions). This station was located west of Bayou Casotte. As with the other constituents, all stations showed changes in salinity, which indicated circulation changes, but were considered insignificant.

Notwithstanding the potential harm to some individual organisms, no significant impacts to managed species of finfish or shellfish populations are anticipated from the proposed dredging and placement 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 channel area after activities cease.

In accordance with the NMFS EFH conservation recommendations and the Magnuson-Stevens Act, the USACE has prepared and provided NMFS with a comprehensive EFH assessment for the continued operations and maintenance of the Pascagoula Harbor, to ensure full review of potential impacts on the habitat and species found in the EFH. The proposed action is not expected to cause any significant adverse impacts to Essential Fish Habitat or EFH species. Impacts are expected to be minor on an individual and cumulative effects basis.

The USACE, Mobile District and the JCPA will continue to coordinate with the NMFS Habitat Conservation Division as alternative dredge material disposal options involving BU to restore coastal habitats are explored and potentially implemented. Such beneficial projects, if properly designed and executed, would have the potential to substantially benefit federally managed fish species by the creation, restoration, and enhancement of EFH through activities such as marsh and barrier island restoration.

4.14.3 Essential Fish Habitat - Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.15 Socio-Economics

Socioeconomic impacts would be considerable if the Proposed Action would result in a substantial negative effect upon employment, income, or housing in the vicinity of the project study area or within the region.

4.15.1 Population

4.15.1.1 Population Alternative A - No Action

Without the Proposed Action, the transit inefficiency would continue throughout the harbor and there is the potential for the harbor to experience increased congestion in the future.

4.15.1.2 Population - Proposed Action (Alternative 11)

The widening of the navigation channel would allow a reduction in the wait time for ships entering and exiting the navigation channel. As a result of the decrease in transit delay times at the Port, cargo would be transported through the Port more efficiently. This efficiency could potentially result in additional jobs and economic stimulation from taxes and fees. This economic stimulation may attract more workers who need housing in the area. Minor impacts would be considered beneficial, but overall, impacts to population would be considered insignificant.

4.15.1.3 Population Alternative (All Others)

These alternative(s) are similar to the Proposed Action and would result in impacts that would be less than significant.

4.15.2 Employment and Income

4.15.2.1 Employment and Income Alternative A - No Action

Without the Proposed Action, the transit inefficiency would continue throughout the harbor and there is the potential for the harbor to experience increased congestion in the future.

4.15.2.2 Employment and Income - Proposed Action (Alternative 11)

The widening of the navigation channel would allow a reduction in the wait time for ships entering and exiting the navigation channel. As a result of the decrease in transit delay times at the Port, cargo would be transported through the Port more efficiently. This efficiency could potentially result in additional jobs and economic stimulation from taxes and fees. This economic stimulation may attract more workers who need housing in the area. Minor impacts would be considered beneficial, but overall, impacts to employment would be considered insignificant. The estimated economic impact of the Bayou Casotte Harbor Channel Improvement Project for the State of Mississippi is $40,747,673 in sales, 414 jobs, $19,927,796 in labor income, and a contribution of $26,568,928 to GRP.

4.15.2.3 Employment and Income Alternative (All Alternative)

While the estimated construction costs vary for all alternatives, the estimated impacts are not considered to be significant.

4.15.3 Utilities

Utility impacts would be considered significant if the Proposed Action would result in the interruption of local or regional utility services, thereby posing a substantial inconvenience to the affected population.

4.15.3.1 Utilities Alternative A - No Action

Under the No Action Alternative, existing utility service use or location would not be impacted.

4.15.3.2 Utilities - Proposed Action (Alternative 11)

The Proposed Action may impact a gas utility line during dredging. If it is determined that insufficient cover would be present after dredging is complete, the line, which crosses the Lower Pascagoula Channel, would be relocated prior to dredging that portion of the channel. The Proposed Action would not directly impact any other utility services in the area. No other utility lines would be significantly impacted or would need to be relocated.

4.15.3.3 Utilities Alternative (All Others)

These alternative(s) are similar to the Proposed Action and involves impacts that are considered less than significant.

4.15.4 Public Safety

Public safety impacts are considered significant if the Proposed Action within the Pascagoula Harbor Navigation Channel would 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 area affected.

4.15.4.1 Public Safety Alternative A - No Action

Under the No Action Alternative, existing public safety issues would not change. The USACE, Mobile District would continue to maintain the existing navigation channel with the present dimensions via maintenance dredging. The size of incoming vessels would remain the same under with and without project conditions and emergency response and marine traffic safety issues would continue to be addressed by the USCG.

4.15.4.2 Public Safety - Proposed Action (Alternative 11)

In the Proposed Action, the Bayou Casotte and Lower Pascagoula Channels would be widened via dredging and the dredged sediment would be deposited in several areas surrounding the channel. The dredging contractors would participate in an orientation session with the USCG to address harbor safety operating procedures and protocol, and ensure coordination with marine traffic in the area. In addition, a Notification to Mariners would be published in the USCG's weekly publication indicating areas to be dredged and areas where sediments would be deposited. The Port of Pascagoula would notify the appropriate mapping agencies to revise applicable navigation charts to reflect changes in

channel width due to dredging operations, and to indicate areas of deposition surrounding the channel. No significant impacts to emergency responders for recreational boaters are expected, as depositional areas would be located offshore. No significant impacts to public health are expected from maintenance dredging or the deposition of sediment in locations surrounding the channel.

4.15.4.3 Public Safety Alternative (All Others)

These alternative(s) are similar to the Proposed Action and involves impacts that are considered less than significant.

4.15.5 Land, Water and Transportation

Land, water, and transportation impacts are considered significant if the Proposed Action would 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.

4.15.5.1 Land, Water and Transportation Alternative A - No Action

Under the No Action Alternative, existing conditions in the project study area would not change. The USACE, Mobile District would continue to maintain the existing navigation channel with the present dimensions. No impacts to existing traffic patterns or traffic counts along the local roads, including the nearby highways (US 90, MS 57, MS 613, and MS 63) and interstate (I-10), would occur. No changes to vehicular traffic, to traffic patterns along local rail lines, or to marine traffic patterns within the Port would result from the No Action Alternative.

4.15.5.2 Land, Water and Transportation - Proposed Action (Alternative 11)

The widening of the navigation channel would allow a reduction in the wait time for ships entering and exiting the navigation channel. As a result of the decrease in transit times at the Port, cargo would be transported through the Port more efficiently. Widening of the Pascagoula Harbor's Lower Pascagoula and Bayou Casotte Navigation Channel(s) would allow for a greater range in the size of vessels that would use the channel, and result in an increase in the number of vessels capable of navigating Pascagoula Harbor at night. However, additional vessel calls are not anticipated as a result of implementing the Proposed Action. The Proposed Action would not introduce new or different land uses in the area. Land uses surrounding the Port are primarily industrial, commercial, and residential. The Proposed Action would not conflict with any applicable goals or policies within the area. The Port is currently operational, and USACE, Mobile District has already been approved to maintain and widen the Bar Channel.

During the dredging, recreational activities such as boating, sailing, and fishing along the navigation channel may be temporarily disrupted, limited, or altered. Potential temporary impacts to nearby boaters may include noise, visual intrusion, and turbidity. After the dredging, increased vessel traffic into the Port may slightly alter recreational uses of the channel; overall, however, the impacts from the Proposed Action are considered less than significant.

4.15.5.3 Land, Water and Transportation Alternative (All Others)

While the estimated impacts vary for all alternatives, they are not considered to be significant.

4.15.6 Regional Economic Activity

The Gulf of Mexico is a major socioeconomic asset in terms of fisheries, tourism, agriculture, oil, infrastructure, trade, and shipping. The Gulf region contains one-fourth of the nation's seafood processing and wholesale establishments and provides jobs and recreational activities such as sport-fishing. In 2009, according to the NMFS, the commercial fish and shellfish harvest from the 5 U.S. Gulf states was estimated to be 1.42 billion pounds. In the same year, commercial catches in the Gulf were valued at over $629 million (NMFS, 2011).

In addition, economic conditions and trends in the Gulf coast region are closely associated with land and water 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).

Annual sales volumes for marinas approximate $22 million in Mississippi (Lynch et al., 2003). The Mississippi Sound area includes numerous public access marinas. The Gulf accounts for 30 percent of the U.S. offshore oil production and approximately 23 percent of the U.S. gasoline production. The infrastructure for oil and gas production in the Gulf area is concentrated in coastal Louisiana and east Texas. Approximately 55,000 workers are employed in the Gulf petroleum-related offshore industry.

The USACE Online RECONS is a system designed to provide estimates of regional, state, and national contributions of federal spending associated with Civil Works and ARRA Projects. It also provides a means for estimating the forward linked benefits (stemming from effects) associated with non-Federal expenditures sustained, enabled, or generated by USACE Recreation, Navigation, and Formally Utilized Sites Remedial Action Program. Contributions are measured in terms of economic output, jobs, earnings, and/or value added. The system was used to perform the following regional analysis for the Bayou Casotte Improvements project.

4.15.6.1 Regional Economic Activity Alternative A - No Action

Using data provided by the JCPA, there were over 8,700 calls, or approximately 2,900 per year, occurring between April 2008 and April 2011. Of those calls, around 48 percent were tugs entering/exiting through the GIWW. Excluding the tug fleet, about 36 percent of the remaining vessel call with a LOA greater than 700 feet. Deep-draft vessels with an LOA of greater than 700 feet are restricted to daylight hours only during transit. Under the No Action Alternative, vessels will continue to operate in using the same transit restrictions currently in place for the existing condition. Therefore, 36 percent of the deep draft vessel fleet calling on Pascagoula Harbor will be restricted to daylight only transits. This percentage was held constant throughout the period of analysis; however, with the size of new build vessels becoming larger every year, it is possible that the number of deep draft vessel being delayed could increase. However, for this analysis, since the terminals/berths do not have current plans for expansion, (excludes new berth being constructed at the Chevron terminal), vessels are anticipated to remain relatively consistent with the existing condition. Also, all deep draft vessels will continue to be restricted to one way traffic as those vessels are not allowed to meet within the channel system. This does not include the tug transits that call on the harbor. Inbound and outbound tugs are currently allowed to meet in the channel. All vessels will continue to be restricted by weather related conditions and any tide restriction as well.

Using the commodity forecasts provided in the Port Commerce section of the Economics Appendix and assuming vessels will continue to load in a similar fashion as the existing condition, since deepening is not being evaluated, a future fleet forecast was developed. The future fleet forecast was

developed using the base fleet as the starting point and the historical growth rates for all commodities except petroleum. For petroleum, the Department of Energy Annual Outlook growth rate was used. The Economic Appendix to the USACE Feasibility Study offers additional detailed information supporting conclusions.

The economic analysis provides the estimated vessel fleet for the future in 10-year increments for the first 30 years of the period of analysis, starting with the base year of the project 2017 through 2046. As with the commodity forecast, the vessel fleet forecast remains constant in the analysis after a 30-year period to remain conservative and attempt to reduce the risk and uncertainty of the proposed project.

The estimated future vessel fleet was run through the HarborSym widening model to calculate the transiting times and costs for the period of analysis for each of the ten year increments (2017, 2026, 2036, and 2046) evaluated. Once the transiting times were calculated, they were presented to the harbor pilots and the non-federal sponsor to ensure that the outputs seemed reasonable. In this case, pilot judgment was critical due to the increase in traffic in the future. Both the pilots and the port authority provided positive feedback regarding the modeling results. The outputs from the HarborSym model for the with/without project, along with additional detail about the model itself is provided in the Proposed Action and other Alternatives evaluation of this section of the EIS.

In addition to the current fleet calling on Pascagoula Harbor, under future conditions Angola LNG Supply Services (ALSS) will call on the Gulf LNG terminal with a fleet of seven new tankers specifically built to transit between Soyo, Angola and Pascagoula Harbor. Four vessels are being constructed by Samsung (SHI) in Korea and chartered to Supply Services on a long term basis from a joint venture comprised of Mitsui & Co., NYK Lines, and Teekay Shipping. The remaining three vessels are being constructed by Daewoo (DSME) in Korea and chartered to Supply Services on a long term basis from Sonangol Shipping Holding Ltd. Chevron Shipping is the operator for Sonangol Shipping. These 165,000 bcm vessels have a LOA of 954 (meaning these vessels will be restricted to daylight traffic only throughout the period of analysis), and beam width of 142, and a design draft of 39 feet. These seven vessels will service only this trade route to ensure that the facility in Soyo, Angola does not have to cease operations at any time. These vessels are anticipated to make around 72 calls annually or one call every 5 days.

Once these vessels arrive, there will be a safety zone imposed of 1,000 feet (bow/stern) on other transiting vessels within the harbor. Under the No Action Alternative, delays would accrue to the LNG vessels when wind and water current conditions are such that the harbor pilots would not allow the vessel to transit the system. The harbor pilots have stated that with a 350-foot channel, they intend to restrict LNG vessel transits when winds exceed 15 knots or water currents exceed 1.25 knots. During this delay, the LNG vessel would either wait at the sea buoy until conditions improve or divert to the nearest LNG facility available. For the Pascagoula Harbor analysis, Sabine Neches was chosen as a representative facility. The facilities located at Lake Charles, LA and Freeport, TX would also be able to handle diverted cargo, however Sabine was chosen as the representative harbor that the LNG vessel would call on since it was the middle of the three distances. The assumption was made that with three potential harbors to call on, Angola, Inc would divert their vessel to the harbor with the available storage capacity and berthing space necessary to accommodate the vessel, thereby avoiding additional delays to the vessel. Also, the chance of additional delays at those harbors due to climate conditions would decrease due to the channel width for each. Bayou Casotte, with a 350-foot wide channel, is the narrowest of the four harbors.

The increase in voyage time to Sabine would be approximately 0.7 days, or 16.8 hours, however, due to the costs associated with shutting down the LNG facility in Angola, any delay at Pascagoula Harbor greater than 4 to 6 hours, would result in a diversion due to the night time transiting restriction placed on a vessel with a LOA the size of the LNG fleet. There are three costs associated with the diversion.

The first is the additional terminal costs for the vessel unloading, storage, regasification, and gas send out. ALSS has contracts in place with the facilities located at Bayou Casotte Harbor. Therefore, ALSS pays fees to the terminals at this facility whether they call on Bayou Casotte or divert to the next closest facility. Therefore, when a vessel is diverted to the closest available facility, there is a terminal cost associated with transporting the liquefied gas at both the terminal in Bayou Casotte and the alternative terminal. The additional cost is an increase in the total cost of transporting the LNG gas from Soyo, Africa to the market point within the United States. This cost is anticipated to be between $1.4-1.6 million per vessel. However, for this analysis, the additional terminal costs were not included in the Economic Analysis, except in a sensitivity scenario. This is due to ease the concern that because resources are not being used at the facility in Bayou Casotte that the additional terminal cost does not meet the criteria of a resource used, and should not be included when calculating net benefits. The second cost results from the additional pipeline transportation cost to reach ALSS customer delivery points. This cost is anticipated to reach $1.7-1.9 million. Finally, there are costs associated with the additional fuel cost while the vessel transits to the alternative terminal and return voyage to Soyo, Angola. This cost is estimated at $300,000. Excluding the additional terminal costs, each diverted vessel costs between $2 million and $2.2 million. (These potential costs are explained in further detail in the Project Benefits section of the Economics Appendix under Vessel Diversion Costs). The cost of diverting a vessel does not compare to the costs associated with terminating operations at the LNG facility in Angola. A facility shutdown is anticipated to cost around $21 million for each occurrence. Also, constructing additional storage capacity at the facility in Soyo so that the vessels can accommodate additional delays at Bayou Casotte is not economically justified. According to ALSS representatives, the storage tanks at the Soyo facility make up approximately 80 percent of the total project cost. The total project cost in U.S. dollars has been reported between $8 and $10 billion. Evaluating these numbers, it is feasible that ALSS would choose to divert a vessel or potentially risk a temporary shutdown in production.

The possibility of temporarily acquiring another vessel to fill in for a delayed vessel was evaluated as well. This option was ruled out (see Economics Appendix to USACE Feasibility Study).

Considering the factors listed above, it is economically beneficial for an LNG vessel to divert to the nearest available LNG facility, rather than temporarily acquiring another vessel to fill the void. Under the without project condition, is it estimated that there is a 6 percent chance of an LNG vessel being diverted. This estimate is based on wind speed and water current data for the Port of Pascagoula. As previously declared, the harbor pilots have stated that a LNG vessel would not be allowed to transit anytime the wind speed exceeded 15 knots along with a water current of 1.25 knots. Therefore, it was necessary to determine how often these two environmental factors would occur. The wind speed at Pascagoula was evaluated using data provided by windalert.com. The data provided displays the number of days that the average wind speed was greater than 15, 20, or 25 miles per hour. This data was later converted to knots for the analysis to determine the probability of a 15 knot wind by interpolating between 20 (17.38 knots) and 15 (13.034 knots) miles per hour. The water current was evaluated using NOAA tide data. The NOAA data was evaluated at 6-minute intervals to determine the likelihood of having a current greater than 1.25 knots.

Using the data provided in the Economics Appendix, the probability of both a 15 knot wind and a 1.25 knot current is 6 percent. With a 6 percent chance for diversion, the estimated number of LNG vessel calls that would be diverted was calculated using a random number generator in Microsoft Excel. Excel provided a number between 0 and 9,999 for each of the anticipated 72 calls per year. If the value returned was less than 600, then the assumption was made that a vessel would need to be diverted. To ensure that the results were not skewed, 5,000 iterations were evaluated. The resulting number of vessels diverted range from a maximum of 12 to a minimum of 0. The average number of diverted vessels over the 5,000 iterations was 4.31. Therefore, for the economic analysis, 4.31 vessels were used as the annual number of diverted vessels for the existing condition. As previously stated,

a LNG vessel diversion would increase the total transportation cost between $2 million and $2.2 million for each vessel. Therefore, the annual increase in cost would range from around $8.6 to $9.5 million.

4.15.6.2 Regional Economic Activity - Proposed Action (Alternative 11)

This document section summarizes the analysis and provides estimates of the regional economic impacts for the Bayou Casotte Harbor Channel Improvements Project. The USACE, Institute for Water Resources, the Louis Berger Group and Michigan University developed the regional economic impact modeling tool called RECONS to provide estimates of regional and national job creation and retention and other economic measures such as income, value added, and sales. This modeling tool automates calculations and generates estimates of jobs and other economic measures such as income and sales associated with USACE's ARRA spending and annual Civil Work program spending. This is done by extracting multipliers and other economic measures from more than 1,500 regional economic models that were built specifically for USACE's project locations. These multipliers were then imported to a database and the tool matches various spending profiles to the matching industry sectors by location to produce economic impact estimates. The Tool will be used as a means to document the performance of direct investment spending of the USACE as directed by the ARRA. The Tool also allows the USACE to evaluate project and program expenditures associated with the annual expenditure by the USACE. The Tool has been developed in both a desktop and on-line version.

This Regional Economic impact analysis was evaluated at three geographical levels: Local, State and National. The local level represents the Pascagoula impact area which encompasses the area included in about a 40-mile radius around the project area. The State level is the State of Mississippi. The National level consists of the 48 contiguous United States.

Table 4.15.6.2-1 displays the overall spending profile that makes up the dispersion of the total project construction cost among the major industry sectors. The spending profile also identifies the geographical capture rate, also called LPC, in RECONS, of the cost components. The geographic capture rate is the portion of USACE spending on industries (sales) captured by industries located within the impact area. In many cases, IMPLAN's trade flows RPCs are utilized as a proxy to estimate where the money flows for each of the receiving industry sectors of the cost components within each of the impact areas.

Table 4.15.6.2-1: *Spending and LPCs*

Category	Spending (percent)	Spending Amount	Local	State	National
			LPC (percent)	LPC (percent)	LPC (percent)
Fuel	**20%**	**$5,957,400**	**83%**	**86%**	**89%**
Consumable Operating Expenses -- Textiles, Lubricants, and Metal Valves and Parts	**10%**	**$2,978,700**	**16%**	**24%**	**71%**
Consumable Operating Expenses -- Restaurants	**1%**	**$417,018**	**100%**	**100%**	**100%**
Repairs and Equipment	**40%**	**$11,914,800**	**95%**	**95%**	**100%**
Labor	**20%**	**$5,957,400**	**5%**	**5%**	**100%**
Consumable Operating Expenses -- Other Food and Beverages	**9%**	**$2,561,682**	**13%**	**24%**	**92%**
Total	**100%**	**$29,787,000**	**-**	**-**	**-**

Table 4.15.6.2-2: ***Overall Summary Economic Impacts***

Impact Areas		Regional	State	National
Impacts				
Total Spending		$29,787,000	$29,787,000	$29,787,000
Direct Impact				
	Output	$17,762,361	$18,470,410	$28,055,394
	Job	124.50	130.16	286.17
	Labor Income	$8,265,117	$8,571,372	$15,426,684
	GRP	$10,450,788	$10,953,875	$18,488,444
Total Impact				
	Output	$23,197,590	$26,952,503	$69,798,648
	Job	165.50	202.87	532.11
	Labor Income	$9,766,573	$11,291,326	$28,838,015
	GRP	$13,527,797	$15,850,816	$42,143,669

Table 4.15.6.2-3 presents the economic impacts by Industry Sector for the region. Impacts at the National level show a tremendous expansion most certainly due to the many multiple turnover of money that ripples throughout the national economy.

Table 4.15.6.2-3: ***Economic Impacts at Regional Level***

IMPLAN No.	Industry Sector	Sales	Jobs	Labor Income	GRP
	Direct Effects				
115	Petroleum refineries	$4,881,187	0.60	$130,887	$577,452
198	Valve and fittings other than plumbing manufacturing	$2,426	0.01	$660	$1,185
319	Wholesale trade businesses	$166,660	1.18	$66,521	$127,180
323	Retail Stores - Building material and garden supply	$389,711	5.07	$174,836	$260,112
324	Retail Stores - Food and beverage	$255,237	4.77	$127,524	$185,898
332	Transport by air	$0	0.00	$0	$0

333	Transport by rail	$8,581	0.02	$2,857	$4,900
334	Transport by water	$1,616	0.00	$274	$668
335	Transport by truck	$40,165	0.30	$19,664	$22,881
337	Transport by pipeline	$1,493	0.00	$362	$348
413	Food services and drinking places	$417,018	7.98	$138,681	$210,409
417	Commercial and industrial machinery and equipment repair and maintenance	$11,300,397	98.07	$7,304,981	$8,761,885
5001	Labor	$297,870	6.49	$297,870	$297,870
69	All other food manufacturing	$0	0.00	$0	$0
	Total Direct Effects	$17,762,361	124.50	$8,265,117	$10,450,788
	Secondary Effects	$5,435,229	41.00	$1,501,456	$3,077,008
	Total Effects	**$23,197,590**	**165.50**	**$9,766,573**	**$13,527,797**

Total Bayou Casotte Harbor Channel Improvement Project Economic Impact for the State of Mississippi geographical area is composed of $23,197,590 in sales, 166 jobs, $9,766,573 in labor income, and a contribution of $13,527,7978 to GRP. Additional information pertaining to the regional, state, and national benefits is found in the Economic Appendix of the USACE Feasibility Study.

4.15.6.3 Regional Economic Activity Alternative (All Others)

While the estimated construction costs vary for all alternatives, the estimated impacts are not considered to be significant. Further details are found within the Economics Appendix of the USACE, Mobile District Feasibility Study and as described above in the Proposed Action section.

4.15.7 Pascagoula and the Port of Pascagoula

The significance criterion for navigation and ports would be a significant change to the vessel transit efficiency at Pascagoula Harbor.

4.15.7.1 Pascagoula and the Port of Pascagoula Alternative A - No Action

Under the No Action Alternative, the existing navigation channel would remain unchanged. The USACE, Mobile District would continue to maintain the channel with the present dimensions.

4.15.7.2 Pascagoula and the Port of Pascagoula - Proposed Action (Alternative 11)

The Port of Pascagoula is a major port in Mississippi, supporting national and international shipping commerce. Increased harbor access for deep-draft ships would be expected to make a positive contribution to the overall economy of the area. Implementation of the Proposed Action is not expected to impede commercial shipping navigation within shipping channels. Widening the shipping channel would allow the Port of Pascagoula and private companies with shipping operations to receive commercial traffic from larger vessels. The Panama Canal Authority completed an expansion project in 2016, which allowed larger vessels to be able to transit the canal. Previously, the canal only accommodated container vessels up to 4,500 twenty-foot equivalent units (TEUs) in size. The expanded canal was designed for ships as large as 12,500 TEUs. Implementation of the Proposed Action would help sustain and grow commercial shipping business in Pascagoula, including additional shipping through the Panama Canal, into the future.

Commercial shipping could experience minor temporary delays from dredging and disposal activities. However, the dredge contractor would be required to move work vessels to accommodate commercial shipping. These impacts would recur whenever maintenance dredging is conducted. However, dredging would be coordinated with Harbor Control to minimize and avoid impacts to commercial traffic. Dredge trips to the disposal area would occur around times of heavy commercial traffic without adversely affecting commercial shipping. Recreational boat traffic would be precluded from using active dredge and disposal areas during the work, but these impacts would be temporary. It is anticipated that channel widening would take several months to complete. However, the dredging would not require any closure of the channel. The dredging contractor would participate in an orientation with the USCG prior to dredging activities to ensure coordination with existing marine traffic in the area. Prior to dredging, a Notification to Mariners would be published in the USCG's weekly publication. As required by law, all project-related vessels would comply with the Federal Navigation Rules established by the USCG. Because of Port-required coordination with the USCG and the limited duration of the Proposed Action, construction impacts on vessel transportation would be temporary and minor. Port pilots would still be used to bring commercial ships into the Port, so there would be no substantial difference in operations for large commercial ships.

As a result of the Proposed Action, there would be improved vessel transit efficiency at Pascagoula Harbor.

4.15.7.3 Pascagoula and the Port of Pascagoula Alternative (All Others)

These alternative(s) are similar to the Proposed Action and involves impacts that are considered less than significant.

4.16 Environmental Justice

EO 12898, Environmental Justice (EJ), urges each Federal agency to achieve EJ by addressing "disproportionately high and adverse human health effects…on minority and low-income populations." Disproportionate environmental health and safety risk impacts to either minority populations or low-income populations would also be considered noteworthy.

A minority population exists where the percentage of minorities in an affected area either exceeds 50 percent or is meaningfully greater than in the general population of the larger surrounding area. The term "minority population" includes persons who identify themselves as African American, Asian or Pacific Islander, Native American or Alaskan Native, or Hispanic. "Race" refers to ethnicity and language, not race, and may include persons whose heritage is Puerto Rican, Cuban, Mexican, and Central or South American.

Low-income populations can be identified using the Bureau of the Census' statistical poverty threshold, which is based on income and family size. The Census Bureau defines "poverty area" as a census tract where 20 percent or more of the residents have incomes below the poverty threshold and an "extreme poverty area" as one with 40 percent or more below the poverty level (U.S. Census Bureau, 2016). The "census poverty level" refers to income levels, based on family size, age of householder, and number of children under 18 years of age, that are considered too low to meet essential living requirements. The criteria for determining poverty level are applied nationally (except for Alaska and Hawaii), without regard to the local cost of living. For the 2016 Census, the poverty threshold for a family of four was $24,250.

4.16.1 Environmental Justice Alternative A - No Action

Under the No Action Alternative, there would be no sizeable direct impacts to minority populations, children under the age of 18, or families below the poverty level in the areas immediately adjacent to the Port.

4.16.2 Environmental Justice - Proposed Action (Alternative 11)

The area surrounding the Port is primarily industrial, residential, and commercial land uses. The Proposed Action would not require relocation of any populations surrounding the Port and is not expected to adversely affect or disproportionately impact any minority population, children, or low-income families. Census Tract 420 Block Group 4 (73.2 percent) and Census Tract 421 Block Group 1 (56.7 percent) have higher minority populations than the City of Pascagoula (41.2 percent), Jackson County (27.9 percent), and the state average of 40.9 percent. However, these two specific areas are located farthest away from the Port and any proposed project activities. Census Tract 427 Block Group 2 (9.6 percent) includes the Port and spans northward to U.S. Highway 90 and eastward to the Mississippi/Alabama state line. Because this area is largely comprised of industrial use with some residential and commercial use which is located primarily away from where the project activities would occur, no impacts would as a result of the Proposed Action. Census Tract 426 Block Group 1 (16.7 percent) includes a mainly residential use located along the western alignment of Bayou Casotte Federal Channel.

Impacts to minority and low-income populations are considered less than significant.

4.16.3 Environmental Justice Alternative (All Others)

These alternative(s) are similar to the Proposed Action and involves impacts that are considered less than significant.

4.17 Protection of Children

EO 13045, Protection of Children from Environmental Health Risks and Safety Risks, was designed to safeguard children from adverse exposure to environmental and human health conditions. Disproportionate environmental health and safety risk impacts to children would also be considered noteworthy.

4.17.1 Protection of Children - Alternative A - No Action

No disproportionate environmental health and safety risk impacts to children are expected as a result of the No Action Alternative.

4.17.2 Protection of Children - Proposed Action (Alternative 11)

Given the distance between the shore-based population and the dredging activities, no children are likely to be exposed to any potential sources of direct impact. Impacts to children are considered less than significant.

4.17.3 Protection of Children - Alternative (All Others)

These alternative(s) are similar to the Proposed Action and involves impacts that are considered less than significant.

4.18 Unavoidable Adverse Environmental Effects

Every reasonable effort will be made to ensure that unavoidable adverse environmental effects that could not be avoided would be temporary and localized, minor and short term in nature, or fully mitigated as necessary to reduce impacts.

4.19 Irreversible and Irretrievable Commitments of Resources

The potential for significant irreversible or irretrievable commitments of resources involved in all of the proposed alternatives have been considered and are unanticipated at this time. Further evaluation will be conducted to determine if any of the proposed plans would present minor impacts in this area. The labor, capital, and material resources expended in the planning and execution of dredging operations and dredged material placement would be irreversible and irretrievable commitments of human, economic, and natural resources. The non-Federal sponsor has committed to financing the construction of the proposed action and for determining the economic justification for Federal assumption of maintenance under authority provided by Section 204b of the WRDA 1986.

4.20 Cumulative Impacts

Cumulative impact is defined as “the impact on the environment which results from the incremental impact of the action when added to other past, present and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or persons undertake such action” (40 C.F.R. § 1508.7). The regulations state further that cumulative impacts can result from individually minor, but collectively significant, actions taking place over a period of time. Finally, ecological effects refer to effects on natural resources and on the components, structures and functioning of affected ecosystems, whether direct, indirect or cumulative.

This analysis considers the impacts of the proposed project in combination with past, present, and other reasonably foreseeable future projects in Bayou Casotte, the City of Moss Point (north of the Port of Pascagoula), and the Mississippi Sound. Potential cumulative impacts to the 20 environmental resources described in this section earlier were evaluated for 13 past, present, and reasonably foreseeable projects.

4.20.1 Cumulative Impact Assessment Methods

This section describes the application of the cumulative impact assessment methods to the proposed project. The geographic area for this assessment encompasses a 5-mile radius around the Port of

Pascagoula, which is appropriate since potential impacts of the proposed project would be localized to the southern end of the Pascagoula River and coastal Mississippi watersheds and would have little effect on the upstream extents. Industrial and beneficial use projects are included in this analysis because of the similarity of their operations and associated impacts to the proposed project, and the resulting potential for cumulative impacts on the impacted resources. Projects evaluated include the following:

Reasonably Foreseeable Future Actions

- Mississippi Integrated Gasification Combined Cycle, Moss Point
- VT Halter Marine
- Beneficial use sites, including Greenwood Island, Singing River, and Round River locations
- Port of Gulfport Expansion Project (outside of 5-mile radius; described qualitatively as potentially significant if restored/expanded)

Past or Present Actions

- Chevron Pascagoula Base Oil Facility
- Gulf LNG Clean Energy Project
- Mississippi Phosphates
- Maintenance Dredging
- Beneficial Use Sites
- Pascagoula Bayou Casotte Terminals
- Pascagoula Harbor Navigation Channel
- Bayou Casotte Navigation Channel and Cyclical Maintenance Dredging

Impacts of these projects on the resources have been evaluated for the proposed project. Several projects are described qualitatively in Sections 4.20.3 and 4.20.4. These projects are outlined below.

The Port of Gulfport Expansion Project was evaluated qualitatively because it is not currently reasonably foreseeable at this time, but is described in Section 4.20.3.6.

The current and proposed Beneficial Use Sites (i.e., Horn Island, Greenwood Island, Singing River, and Round Island) have been evaluated qualitatively because their impacts are generally limited to only a few resource areas; however, they are described in Section 4.20.3. Most of the reasonably foreseeable projects are planned, but do not have definitive implementation schedules due to a variety of factors including funding constraints. The cumulative impact assessment as conducted was based on the general assumption these projects would move forward over the next 1 to 3 years. Best professional judgment was relied upon for cumulative impact assessment to a greater extent than the impact analyses for the proposed project because information on other projects was based entirely on the limited information available in the public domain.

This cumulative analysis covers activities since the landfall of Hurricane Katrina on August 29, 2005. This is consistent with the cumulative impact analysis for the Pascagoula Harbor Navigation Channel EIS, which found that the hurricane's substantial impact on coastal Mississippi and the Port of Pascagoula makes it a reasonable starting point for assessing project impacts (USACE, 2010). With respect to regulatory actions undertaken since Hurricane Katrina, the USACE has issued 23 individual permits, 1 EIS, and 4 permit modifications that include authorizing 122.39 acres of wetland habitat to be filled, 5,527,343 cys of dredged material to be removed, 18 acres of dredge fill, 1.23 acres of dredged material removal, and construction of 17,427 feet of linear structures. Approximately six (6) Nationwide Permits (NWP) are verified annually by the USACE; this trend is not anticipated to

increase. The USACE, Mobile District is not aware of any additional major public or private sector projects, other than those listed above and discussed in Sections 4.20.3 that would result or contribute in a significant manner to cumulative impacts associated with the proposed project.

4.20.2 Evaluation Criteria

Cumulative impacts were determined by reviewing the impacts described in the available documents as well as the resource discussion found earlier in this section of the EIS.

4.20.2.1 Individual Project Evaluation

Individual project documents such as public notices, draft and final EISs, newspaper articles, air pollution permits, hazardous waste reports and project fact sheets were reviewed for impacts to the resource areas. No attempts were made to verify or update those documents, and no field data were collected to verify the impacts described in the above documents. Also, for projects with final EIS documents that have since been constructed, proposed impacts and mitigation plans described in their respective EISs were not verified. Thus, this analysis recognizes that some of the projects are undergoing revisions that may alter their eventual environmental impact, but it has relied upon the best available information in existing published documents. Quantitative impact estimates have been included wherever possible, and summed across projects, but in many cases only qualitative information was available.

4.20.2.2 Resource Impact Evaluation

This analysis includes an evaluation of the biological/ecological, physical/chemical and cultural/socioeconomic impacts of the proposed project and other projects. Each of the evaluated projects is described below. The results section discusses the cumulative impacts on each of the resource areas.

Four General Permits, 14 Standard Permits, 9 Letters of Permission, 34 NWPs, 1 EIS, and 4 Permit Modifications were completed within a 5-mile radius of the proposed project within the last 5 years (USACE 2012a). Ten of the 65 permits or modifications were for impacts affecting 1 or fewer acres of authorized fill projects. The largest permits were for the Chevron Refinery Expansion (66.99 acres) and Gulf LNG (7.43 acres) and the average was 4.25 acres.

4.20.3 Reasonably Foreseeable Future Actions

4.20.3.1 Mississippi Integrated Gasification Combined Cycle, Moss Point

Mississippi Gasification (MG) has proposed to develop a substitute natural gas facility in Moss Point, Mississippi, approximately 7 miles up the East Pascagoula River from the Port of Pascagoula. The facility will utilize approximately 7,000 tons per day of petroleum coke feedstock to produce 120 million standard cubic feet per day of pipeline-quality substitute natural gas. MG plans to capture 90 percent of the carbon dioxide (CO_2) produced and sell it to Denbury Onshore, LLC, under a long-term contract for enhanced oil recovery (EOR) sequestration. The project also includes construction of a 110-mile CO_2 pipeline to an existing Denbury pipeline to the north. Approximately 119 tons per day of slag (the non-hazardous, vitrified solid product of gasification) would be shipped offsite for sale or disposed of as non-hazardous waste. Up to 12 million gallons of water per day would be supplied from the Escatawpa River, supplemented by water from the Pascagoula River, well water and treated water near the site for industrial processing. The MG complex would utilize approximately 115 acres of floodplains and wetlands in the Moss Point Industrial Technology Complex which are currently undergoing remediation for past contamination from the paper mill previously located on the site and

are designated for industrial use. Operation, maintenance and management of the facility are estimated to require 177 full-time positions (DOE 2009). The NOI to prepare an EIS was issued November 12, 2009, and a July 2014 U.S. Department of Energy (USDOE) key EIS schedule indicates that the project schedule is still under development.

4.20.3.2 VT Halter Marine

VT Halter Marine operates a shipyard in Bayou Casotte for constructing small to medium-sized oceangoing vessels up to 50,000 deadweight tons (VT Halter Marine 2012). VT Halter Marine's shipyard facilities include floating dry docks and mooring basins. The existing facility has an air quality permit that includes emissions of no more than 245 tons per year (tpy) VOC (MSDEQ 2010b) and in 2009 generated 46 tons of hazardous material (EPA 2009). In June 2011 VT Halter Marine filed an application with the MDMR for a coastal wetlands permit and water quality certification to build an additional floating dry dock at their Bayou Casotte facility. The dry dock configuration would be an "L" shaped modular system comprised of two parts and would be approximately 715 feet by 389 feet. During loading operations, the dry dock would be rotated along the edge of the Federal channel limits and submerged by filling the ballast to sink the structure on the channel bottom. This would require dredging a 65-foot deep basin adjacent to the Federal channel. Construction of the floating dry dock would require the dredging of 811,865 cys and the excavation of 189,263 cy of uplands to a depth of 65 feet below mean low water. Suitable dredged material would be utilized for approved beneficial use (MDMR 2011); however, at the time of this writing there is no beneficial use specifically determined for this project. Dredged material placement will require approval by both the MDMR and USACE, Mobile District.

4.20.3.3 Greenwood Island Beneficial Use Site

In 2010 the USACE constructed an 18-acre containment site using riprap barriers. The site is intended to establish a marsh habitat system as dredged material is placed within it. In 2011 the MDMR proposed that the site be expanded by an additional 632 acres for a total of 650 acres (USACE 2012). After the proposed expansion plans became public, opposition mounted. At the present time, the project site is closed and the fate of this project is uncertain.

4.20.3.4 Round Island Beneficial Use Site

In 2011, the MDMR proposed the creation of a 220-acre beneficial use site adjacent to Round Island; an island presently constructed to fully-authorized dimensions as of 2016. The present island is mostly forested uplands with little marsh. Initially, the proposed expansion would take place over 10 years and utilize material from commercial, private, and public dredging projects. The first phase of the project created approximately 20 new acres of upland and marsh habitat in 2014. In 2016, a partnership between USACE, JCPA, MSDMR and MSDEQ allowed for the placement of material from the authorized deepening of the Upper Pascagoula & Pascagoula River Channel(s) utilizing National Fish & Wildlife Foundation (NFWF) funds. The availability of this material and the partnership agreement allowed for the Beneficial Use Site to be expanded to fully-authorized dimensions.

4.20.3.5 Port of Gulfport Expansion Project

The currently proposed Port of Gulfport Expansion Project involves filling of up to 400 acres of open-water bottom in the Mississippi Sound, the construction of wharfs, bulkheads, terminal facilities, container storage areas, intermodal container transfer facilities, dredging and dredged material disposal and infrastructure, and construction of a breakwater of approximately 4,000 linear feet. The USACE issued a NOI to prepare an EIS on March 11, 2011. While this is a planned project, the time of implementation is unknown, therefore it is not considered reasonably foreseeable.

4.20.4 Past or Present Actions

4.20.4.1 Chevron Pascagoula Base Oil Project

Chevron has expanded its Pascagoula Refinery for the Pascagoula Base Oil Project (PBOP). The base oil facility is capable of producing 25,000 barrels a day of base oil, which is used to produce premium lubricants such as motor oil. The project includes additional piping within an existing pipeway to transport feedstock and products, construction of a revetment for shoreline protection near Berth 7A and rerouting of the existing Transportation Workers Identification Credential fence to maintain port security. It also includes additional construction areas associated with the proposed piping, revetment, access roads, trestles, berths and related facilities within the marine area. Chevron filled 2.99 acres in addition to the previously permitted 72.3 acres for a total of 75.29 acres of low-quality wetland; constructed 47,490 square feet of overwater structures in place of the previously permitted 45,792 square feet; and filled up to 0.22 acre of unvegetated benthic habitat for construction of the revetment. Mitigation credits for wetland impacts were obtained from the Rhodes Lake Mitigation Area as authorized by the USACE (USACE et al. 2011). Under the new plan, the refinery would have a net decrease of 86.53 tons per year of carbon monoxide. Nitrogen oxide emissions would reach 303.32 tons per year, also less than originally planned (Havens 2010). The refinery would emit 99.19 mcy VOC (MSDEQ 2010a). The facility is expected to generate 1,000 jobs over 2 years, with 20 permanent salaried positions. Construction of the PBOP began in October 2011 and was completed in 2014 (Wilkinson 2016).

4.20.4.2 Gulf LNG Clean Energy Project

The project is an LNG import/export terminal located in the Port of Pascagoula with marine facilities for LNG ship loading/unloading, LNG storage, and vaporization. The facilities have a maximum sendout capacity of 1.5 billion cubic feet per day of natural gas. The following is a list of facilities associated with the project:

- a ship berth and loading/unloading facilities (i.e., marine facilities) capable of accommodating one LNG ship
- LNG transfer systems
- two 160,000-cubic-meter, full-containment, LNG storage tanks
- ten high-pressure submerged combustion vaporizers (SCV)
- vapor handling systems
- hazard detection and response equipment, ancillary utilities, buildings, and service facilities
- one 5-mile-long, 36-inch-diameter, natural gas sendout pipeline
- associated pipeline support facilities, including three interconnects/meter stations, one pig launcher, and one pig receiver.

Recent dredging for the Gulf LNG terminal basin used the Bayou Casotte DMMS for material placement and, based on a USACE estimate, the maintenance dredging quantity on a 3-year recurring cycle for the Bayou Casotte DMMS is approximately 580,200 cys (Anchor QEA 2012). Construction and operation of the Gulf LNG facility required about 82 acres of land and affected about 61 acres of bay bottom. According to information presented in the FEIS (FERC 2006), the Gulf LNG Project would have limited adverse environmental impact and the impacts would be most significant during the construction period. The fact that the LNG terminal made use of a site previously used for dredged material placement that has been designated for industrial development, as well as the use of FERC's Plan and Procedures to minimize impact on soils, wetlands, and water bodies have contributed to the reduced amount of long-term impacts associated with the Gulf LNG Project. No adverse impacts to federally or state-listed threatened or endangered species were expected, with the implementation of a Mitigation and Monitoring Plan for the Gulf sturgeon. Approximately 88 acres of wetlands and

vegetation was temporarily impacted and 31 acres permanently impacted; however, a mitigation plan was prepared (FERC 2006). The LNG terminal became operational in October 2011.

4.20.4.3 Mississippi Phosphates

Mississippi Phosphates Corporation (MPC) facilities are located at the northern tip of the Bayou Casotte Channel to the east of the turning basin. MPC production facilities consist of two sulfuric acid facilities, a phosphoric acid facility, and a DAP granulation facility. DAP is produced by combining phosphate rock and sulfuric acid to form phosphoric acid, which is then mixed with ammonia to produce DAP, a dry granular material. The phosphate granulation facility has an annual production capacity of 850,000 tons, while the existing sulfuric acid facilities have sufficient capacity to produce 600,000 to 640,000 tons. If sufficient sulfuric acid is not produced by MPC facilities, supplies are augmented by purchased sulfuric acid. Domestic distribution of DAP is accommodated by rail, truck and barge. The facility emits 48.15 tpy VOC according to its air pollution permit (MSDEQ 2016). Lingering environmental issues are being actively addressed and no new facilities are planned. On March 4, 2011, MPC and the MSDEQ executed an Agreed Order which settled all matters asserted in a series of Notice of Violations with respect to alleged CWA violations, as well as any other NPDES permit violations. Thus, no new environmental impacts are anticipated from continued operation of MPC facilities.

4.20.4.4 Maintenance Dredging

The Port of Pascagoula has been active since the early nineteenth century. By the 1830s, dredging of the eastern segment of the Pascagoula River accommodated larger oceangoing vessels. The Port of Pascagoula Channel was widened to accommodate growing ship traffic in the late 1870s. Bayou Casotte was dredged and the harbor opened to shipping traffic in the late 1950s. The direct environmental impacts of historic dredging activities were rarely recorded. However, the cumulative impact of dredging on barrier islands has been studied in detail (Morton 2007).

In the 1850s the depth across the outer bar in Horn Island Pass was unmodified from its natural depth (14.8 to 16.7 feet). In the 1880s dredging of Horn Island Pass began and work started on the ship channel to Pascagoula (USACE 1935). By 1935 the dredged channel across the outer bar in Horn Island Pass had been deepened to 18.7 feet (USACE 1935). In 2005 the maintained dimensions of the outer bar channel were 43.3 feet deep and 443 feet wide and maintained dimensions of the Horn Island Pass Channel were 41.3 feet deep and 590.6 feet wide (Morton 2007).

The dredged entrance channel at Horn Island Pass is not stabilized by jetties and, with a dredged depth of over 23 feet below its natural depth, the channel acts as a trap for sediment moving west along Petit Bois Island (Morton 2007). A segment of the channel near the west end of Petit Bois Island was dredged to a depth of 55.1 feet to intentionally entrap sediment (Morton 2007).

The cumulative effect, from the nineteenth century to present, of deepening of the Horn Island Pass navigation channel through the outer bars is the impedance of sediment transport across the pass to the downdrift barrier islands. Historically, the trapped sediment was dredged and disposed of in areas where it was unavailable for barrier island nourishment. The timing and magnitude of channel dredging generally matches the historical trend of barrier island land loss (Morton 2007). Between 1848 and 2005 Petit Bois Island lost 54 percent of its land area and Horn Island has experienced cumulative land loss of 11 percent since 1849 (Morton 2007).

4.20.4.5 Beneficial Use Sites

Conventional disposal of dredged material typically has been accomplished by placement in sites along the margins of the channels or in unconfined open-water disposal sites offshore of Horn Island. However, as traditional disposal areas are becoming more constrained, consideration of potential new locations for the beneficial use of dredged sediment has increased in recent years. New or expanded beneficial use sites at Greenwood Island, Singing Island, and Round Island are under discussion.

The LZPA is located just west of Horn Island Pass and south of Horn Island. This site is designated to beneficially use material dredged from the channel near Horn Island Pass. Dredged material is pumped to an area west of the Federal channel where it is reintroduced into the east-to-west sediment transportation system. The LZPA was positioned specifically to maximize sand migration to supplement the barrier island system. Suitable, sandy material dredged during new work or channel maintenance efforts are placed within the LZPA as a beneficial use of dredged material.

In addition to placement of dredged material in the LZPA, three additional types of beneficial uses are possible along the Mississippi Gulf Coast: marsh creation, small bird islands, and mosquito ditches (USACE 2010). Marsh creation is possible when dredged material is used to raise the intertidal elevation of the substrate. Small bird islands may be created where dredged material is placed in contained areas to form new habitat for migratory and resident bird populations. Dredged material could also be used to fill coastal “mosquito ditches” dug in the 1950s.

4.20.4.6 Port of Pascagoula Bayou Casotte Terminals

The JCPA operates four public terminals (E, F, G, and H) located just south of the MPC facility along the Bayou Casotte Harbor. These terminals accommodate a variety of conventional general cargo and dry-bulk materials in both foreign and domestic trade. The proposed project will have a positive interaction with the general operations of these terminals by providing more efficient use of the Bayou Casotte Harbor; however, no additional environmental impacts are anticipated as a result of continued operation of these four terminal facilities.

4.20.4.7 Pascagoula Harbor Navigation Channel

In 2010, the USACE Mobile District completed a FSEIS examining the potential impacts associated with the construction of authorized improvements to the Pascagoula Navigation Channel (USACE 2010). The improvements considered included many alternatives for widening and deepening the channel as well as improvements to the turning basins and the impoundment basins. The FSEIS reviewed a previous EIS completed for Pascagoula Harbor in 1985 and provided updates on any new conditions since its publication.

The Proposed Action considered in the FSEIS includes widening and deepening of the Pascagoula Navigation Channel to its federally authorized dimensions as follows:

- Widen the Bar Channel to 550 feet
- Deepen the upper Pascagoula Channel segment to 42 feet
- Deepen the Horn Island Impoundment to 56 feet
- Advanced maintenance dredging of the entire Federal Pascagoula Harbor Navigation

Dredged material will be placed in the existing Pascagoula ODMDS. Material with sand content above 70 percent will be placed in the LZPA to maintain sediment supply to the barrier island system.

4.20.4.8 Pascagoula Harbor Navigation Channel and Maintenance Dredging

The Bayou Casotte Navigation Channel is actively used for shipping and requires periodic dredging to maintain its intended dimensions. Dredging is performed by hydraulic, including hopper and cutterhead pipeline, or mechanical dredge. Historically, material from the inner harbor was placed on Greenwood Island but is now placed at the Bayou Casotte DMMS and/or the ODMDS (USACE 1992). Material from approximately Mile 1.75 to Mile 3 on the Lower Pascagoula River has been placed either in Triple Barrel and/or the ODMDS (USACE 1992). Material from the Mississippi Sound has been placed in open water disposal areas and/or the ODMDS (USACE 1992). Dredging cycles occur irregularly every 12 to 36 months. Areas of the channel affected by shoaling are targeted for dredging and not all portions of the channel are dredged in each cycle.

4.20.5 Results

The sections below describe potential cumulative impacts anticipated as a result of the proposed project combined with past, present and reasonably foreseeable future actions affecting the study area on the 20 resource areas described earlier in this section of the EIS.

4.20.5.1 Physical Environment

4.20.5.1.1 Geology

The proposed project will dredge approximately 3.4 million cys of material to widen the Lower Pascagoula Channel and Bayou Casotte Channel. In addition, approximately 2.7 million cys would be dredged every dredging cycle to maintain project dimensions. Several other projects involve dredging (e.g., Gulf LNG, Maintenance Dredging, Beneficial Use Sites, and Pascagoula Harbor Navigation Channel) leading to a cumulative net impact of 6.35 million cys of dredged material relocated to disposal areas, plus approximately 2.7 million cys additionally dredged each year in maintenance. The project actions would lead to permanent removal of previously unimproved bottom sediments; however, the total amount removed is not expected to interfere with the natural movement and deposition of sediments in the Mississippi Sound and because the underlying bedrock formations would not be altered, cumulative impacts from the listed projects to geological resources are considered to be negligible. However it should be noted that impacting bedrock in this area would be unlikely, if not impossible, considering the depth required to reach underlying bedrock.

4.20.5.1.2 Bathymetry

The proposed project would permanently alter the bathymetry of the 100-foot corridor to be widened along the existing channel; the depth increased from between 9 to 13 feet MLLW. However, the alteration would be minor and the project would have no permanent effects. Other projects discussed in Sections 4.20.3 and 4.20.4 would also involve dredging (Gulf LNG and Pascagoula Harbor Navigational Channel maintenance dredging). The cumulative bathymetric impacts of all these actions is not expected to be significant because no permanent change in depth would occur that affects circulation patterns, currents, tides, and/or water movement within the Mississippi Sound.

4.20.5.1.3 Oceanography

Coastal processes include tides, currents, and consequently, sediment transport. Potential cumulative impacts to coastal processes would be considered significant if there were a substantial alteration in these aspects of the Mississippi Sound as a consequence of implementing the listed projects. Horn and Petit Bois islands have lost area since the 1840s in response to storm frequency and intensity, relative sea level rise, and sediment supply. This pattern of sediment loss is expected to continue, and

the cumulative impact of dredging associated with the proposed project and the other listed projects has the potential to increase the vulnerability of coastal barrier islands by maintaining these altered sediment delivery patterns. However, the cumulative impact of the proposed project in concert with the other listed projects is not a substantial alteration to the existing pattern of sediment loss. The past and present projects are already contributing to the altered sediment transport patterns, and of the reasonably foreseeable projects, only one involves dredging and the rest involve beneficial use. Additionally, the beneficial use of dredged material as a result of the proposed project will slightly reduce erosion occurring at Horn Island. Thus, the cumulative impact of the proposed projects and other listed projects is not anticipated to be significant.

4.20.5.2 Sediments

Sediment related cumulative impacts involving the listed projects would occur during dredging and placement of dredged material. A significant cumulative impact would be a change in sediment characteristics that results in a permanent change in sediment quality, a decline in water quality as a result of sediment/water interactions, or temporary and permanent impacts to biological resources. Available sediment and water quality data obtained for the Pascagoula Harbor Navigation Channel SEIS did not find elevated concentrations of contaminants (USACE 2010). However, the SEIS did state low concentrations of contaminants could be suspended in the water column during dredging. The sediments to be dredged associated with the proposed project have a high silt and clay content (Anchor QEA 2012). Elevated levels of arsenic were found in some sediment samples, but did not exceed PEL guidance criteria. Bioaccumulation evaluations performed on two test organisms found elevated levels of arsenic, copper and lead. However, only lead was at a level requiring concurrence by the EPA prior to placement of dredged material; concurrence is needed to determine whether the sediments meet guidance for the Limiting Permissible Concentration for lead. Similar bioaccumulation studies were performed for pesticides and other contaminants and found for both dioxin congeners and one SVOC. Based on available information, impacts to sediment quality are expected to be temporary and not significant.

4.20.5.3 Climate

In concept, sea level rise will increase the elevation of tides and the height of storm surge activity; thus, any cumulative impact resulting from the alteration of navigation channels in Pascagoula Harbor or of shoreline features within Bayou Casotte Harbor would be minimal compared to the much larger influences resulting from changes in the Gulf of Mexico. While individual projects may create greater opportunities for tidal exchange and increase the amplitude for tides (associated with channel enhancement), these impacts are small in comparison to the predicted consequences of sea level rise alone. The listed projects could accelerate geomorphic change (i.e., land loss) for some barrier Islands with the alteration of sediment delivery across the navigation channel.

Limited information was available on this topic for the listed projects. What can be determined is that a temporary and insignificant amount of GHG emissions would be associated with those projects involving dredging and dredge material placement. Thus, the cumulative climate change impact attributed to the dredging components of the listed projects is not considered to be significant.

4.20.5.4 Air Quality

Air emissions of major contaminants (i.e., VOC, NO_x, etc.) from dredging operations, construction vessel emissions and on-road vehicle emissions were estimated for the proposed project and compared to the 2002 emissions inventory for Jackson County. Due to the relative short-term duration of the channel widening activities (18 months estimated for overall project completion, however substantially less for each channel segment), no long-term cumulative impacts to the area air quality are anticipated. Estimates of reasonably foreseeable future actions are not yet available; however, estimates of emissions from past and present actions have been discussed earlier in this Section of

the EIS. The significance criteria for air quality cumulative impacts would be an exceedance of a chronic or acute state air quality standard caused by the proposed project in conjunction with other listed projects. The contribution of the proposed action in conjunction with other listed projects is determined not to have a significant cumulative impact on overall Jackson County air quality.

4.20.5.5 Noise

Dredging and associated noise generated by dredging vessels and dredge material placement for the proposed project and for the other projects described in Sections 4.20.3 and 4.20.4 will be temporary in nature, thus impacts on marine wildlife such as displacement will be short-term. All of the mentioned projects are located within an industrial area and the additional noise that would be produced during construction would be consistent with the surrounding environment. Those projects resulting in new industrial facilities and/or operations would include noise attenuation features and would operate within local noise control standards. Underwater noise generated during dredging operations may cause marine species to temporarily avoid the general area, but species should return once dredging operations are terminated.

4.20.5.6 Water Supply

The proposed project will have no impact upon water supply in the study area. However, past and future actions are subject to regulatory authority by the USACE and impacts to water supply and/or losses would be mitigated. Thus no significant cumulative impact is anticipated.

4.20.5.7 Marine Sanctuaries

The proposed project will have no impact upon marine sanctuaries as none are located within the study area. Thus no significant cumulative impact is anticipated.

4.20.5.8 Aesthetics

Construction of the proposed project and for the other projects described in Sections 4.20.3 and 4.20.4 will temporarily impact aesthetics during construction activities; however the area is highly industrialized port area and the presence of the construction equipment would be similar to the type of equipment commonly seen in the area. Thus no significant cumulative impact is anticipated.

4.20.5.9 Cultural Resources

Numerous surveys have been conducted to identify potential cultural resources in the vicinity of Pascagoula Harbor and significant cultural resources have been identified. Thus, it is reasonable to assume that past dredging projects may have inadvertently impacted and resulted in the loss of some cultural resources. Based on a review of previously recorded cultural resources, the proposed project has the potential to adversely affect 22JA516 by further eroding remaining portions of the site.

Future maintenance dredging operations would occur in previously disturbed areas and thus pose limited potential for additional impacts to the previously described cultural resource if mitigation for this resource has been completed prior to future maintenance dredging. Construction of new facilities and pipelines associated with the listed projects may also impact the previously described cultural resource. Therefore, any activities should be coordinated with the appropriate regulatory agencies, including the USACE and MDAH, as appropriate, and action taken as directed. Dredged material placement on the Greenwood Island disposal site might also require additional mitigation if the disposal site adversely affects remaining portions of site 22JA516. Should any archaeological artifacts, including human remains, shipwrecks or other cultural resources, be encountered during project

construction, work should cease immediately in the vicinity of the resource, the discovery reported to USACE and MDAH, and action taken as directed.

In fall 2011, limited Phase II testing of site 22JA516 was conducted by Brockington and Associates on behalf of the USACE, Mobile District for the Proposed Action Alternative. During the excavation, a substantial area of intact prehistoric midden was identified and the USACE, Mobile District concluded the site to be eligible for inclusion in the NRHP under Criterion D for its potential to produce important information regarding local and regional prehistoric occupation, including information pertaining to prehistoric cultural chronology, subsistence patterns, intrasite use and mortuary practices (RabbySmith 2012).

To mitigate anticipated impacts to cultural resources that are eligible for listing in the NRHP within the area of potential effect (22JA516), the USACE has entered into an MOA with the MDAH, and the Choctaw Nation of Oklahoma. By letter dated October 23, 2012 the ACHP determined that their participation in consultation to resolve adverse effects was not needed. The MOA includes a work plan for the archaeological Phase III data recovery of 22JA516. The work plan contains the following: environmental and site-specific cultural overviews, an overview of completed cultural resources work at the site, a research design, Phase III archaeological methods, laboratory and specialized analysis methods, methods for curating materials, public interpretation/education, USACE-prepared plan for the treatment of human remains, and an inadvertent discovery plan. Within this plan, the Phase III archaeological methods include a walkover survey/condition assessment, clearing of the work area, limited exploratory excavation, mechanized removal of the upper disturbed sediments, placement of excavation blocks, hand excavation, feature excavation, dewatering of the site, field documentation, collection of samples suited for special analysis, off-site water screening, and soil stripping. Following the investigation, specialized analysis and laboratory processing of collected materials will be undertaken. Unless otherwise specified, all material will be curated at the Charlotte Capers Archives and History (see USACE Letter to SHPO April 18, 2011; MDAH Letters and Burial Excavation Permit May 10 and July 29, 2011; USACE Letters to Tribes – March 5, 2012; Letter from USACE to Advisory Council on Historic Preservation – May 15, 2012; Letter from USACE to SHPO- Notice of Adverse Effects – May 15, 2012; Letter from ACHP- Oct 23, 2012 Correspondence located in Appendix F).

Should any previously unidentified archaeological artifacts, including human remains, shipwrecks or other cultural resources be encountered during project construction, work should cease immediately in the vicinity of the resource, and the discovery should be reported to the MDAH by the USACE, Mobile District immediately.

4.20.5.10 Biological Resources

Cumulative impacts to marine aquatic communities would occur to open-water communities, benthic communities, oyster reefs, artificial reefs and invasive species in ballast water. The primary cumulative concern associated with open water habitats is increased turbidity which occurs as a result of sediment release during dredging. Increased turbidity can be detrimental to primary production associated with phytoplankton and algae by decreasing the light available for photosynthetic activity. Reductions in primary productivity would be localized and would be limited to the duration of plumes associated with dredging. Increased sedimentation would impact juvenile and adult finfish by disrupting foraging and feeding patterns; however these impacts would also be temporary and short-term. While elevated turbidities will impact the adult stages of filter-feeding organisms such as oysters and copepods by clogging filtering mechanisms, long-term cumulative impacts would be short-term and localized.

Cumulative impacts to benthic communities would generally be those associated with dredging and dredge material placement. Those projects involving a modification (e.g., widening) of an existing navigational channel could result in the permanent conversion of shallow, primarily silty clay soft

bottom, to a deeper hypoxic habitat. For example, the proposed action would convert 87.6 acres of the shallow bottom habitat to a deeper and less productive habitat. During implementation of projects involving dredging operations the nature of impacts would consist of increased turbidity and a reduction of water clarity, temporarily impacting primary production and feeding activities of benthic organisms. Dredging activities will temporarily reduce biological diversity and the total biomass of benthic organisms within the impacted zones. However, re-colonization of impacted areas occurs rapidly and no permanent consequences to the benthic community are anticipated to occur as a result of the listed projects. Within the dredged material placement areas, “new” habitat would be created. While species composition may change over time, biological productivity should remain unchanged.

Bottom habitat at the LZPA and ODMDS sites would be buried during dredge material placement affecting benthic communities; however, these sites are approved and active sites for maintenance dredging material placement. Buried organisms would be negatively impacted, but re-colonization would occur rapidly, although shifts in species composition may occur. Artificial reefs are not located in the general vicinity of the proposed project and would not be impacted by maintenance dredging operations.

4.20.5.11 Hard Bottom Habitat

The proposed project will have no impact upon Hard Bottom as there are none located within the study area.

4.20.5.12 Submerged Aquatic Vegetation

The proposed project will have no direct impact upon SAV communities in the study area. However, past and future actions are subject to regulatory authority by the USACE and SAV impacts and/or losses would be mitigated. Thus no significant cumulative impact is anticipated.

4.20.5.13 Marine Mammal and Coastal Bird Communities

Cumulative impacts to marine aquatic communities would occur to open-water communities, benthic communities, oyster reefs, artificial reefs and invasive species in ballast water. The primary cumulative concern associated with open water habitats is increased turbidity which occurs as a result of sediment release during dredging. Increased turbidity can be detrimental to primary production associated with phytoplankton and algae by decreasing the light available for photosynthetic activity. Reductions in primary productivity would be localized and would be limited to the duration of plumes associated with dredging. Increased sedimentation would impact juvenile and adult finfish by disrupting foraging and feeding patterns; however these impacts would also be temporary and short-term. While elevated turbidities will impact the adult stages of filter-feeding organisms such as oysters and copepods by clogging filtering mechanisms, long-term cumulative impacts would be short-term and localized.

Cumulative impacts to benthic communities would generally be those associated with dredging and dredge material placement. Those projects involving a modification (e.g., widening) of an existing navigational channel could result in the permanent conversion of shallow, primarily silty clay soft bottom, to a deeper hypoxic habitat. For example, the proposed action would convert 87.6 acres of the shallow bottom habitat to a deeper and less productive habitat. During implementation of projects involving dredging operations the nature of impacts would consist of increased turbidity and a reduction of water clarity, temporarily impacting primary production and feeding activities of benthic organisms. Dredging activities will temporarily reduce biological diversity and the total biomass of benthic organisms within the impacted zones. However, re-colonization of impacted areas occurs rapidly and no permanent consequences to the benthic community are anticipated to occur as a result

of the listed projects. Within the dredged material placement areas, “new” habitat would be created. While species composition may change over time, biological productivity should remain unchanged.

Bottom habitat at the LZPA and ODMDS sites would be buried during dredge material placement affecting benthic communities; however, these sites are approved and active sites for maintenance dredging material placement. Buried organisms would be negatively impacted, but re-colonization would occur rapidly, although shifts in species composition may occur. Artificial reefs are not located in the general vicinity of the proposed project and would not be impacted by maintenance dredging operations.

4.20.5.14 Threatened & Endangered Species

Critical habitat for the Gulf sturgeon is located north of the barrier islands and within the study area. The Gulf sturgeon is known to migrate through the Mississippi Sound and migrations may occur at any time, although fall and winter are more likely times to encounter this fish. Because the sturgeon feeds on the bottom it is susceptible to capture and/or entrainment during dredging and dredge material placement activities associated with the listed projects. Thus, the cumulative impact associated with dredging activities for the projects listed above, including maintenance dredging, would be limited to incidental contact with foraging individuals. Widening of existing navigational channels, such as the proposed action, would convert shallow bottom habitat to less productive deeper habitat conditions in the immediate vicinity of these projects. The USACE and other action implementers are required to consult with the NMFS regarding potential impact(s) from dredging operations and placement of dredged material to Gulf sturgeon and Gulf sturgeon critical habitat (GSCH). The USACE initiated Section 7 consultation with the NMFS and coordination with the USFWS and received a Planning Aid Letter, dated November 9, 2012. A Final BiOp was received from NMFS on November 4, 2015, stating that dredging of assumed maintenance of the widened channel and placement in GSCH would be covered under the GRBO. See Appendices for agency coordination documentation.

Cumulative impacts to threatened and endangered species may also include the potential for vessel strikes with marine organisms. While sightings are rare, the West Indian manatee is known to migrate through the study area between Florida and Louisiana and could potentially be subject to collisions with shipping vessels. Additionally, several species of sea turtles are known to occur in the study area. The probability of a strike with adult turtles is rare because they prefer deeper waters and the study area does not provide a critical life history function. However, the late juvenile life history stages of sea turtles are benthic and potentially susceptible to capture or entrainment during dredging operations. Federal regulations are in-place to minimize the impact to juvenile sea turtles during use of hopper dredges. NOAA encourages dredging operations to occur during certain time periods to minimize potential impacts.

The Lower Pascagoula Navigation Channel extends between Horn Island and Petit Bois Island, both of which have been designated critical habitat for the wintering piping plover. Despite historic and continued high levels of shipping traffic, and ongoing maintenance dredging, the piping plover continues to winter on these two islands, which suggests the cumulative consequences of all the listed projects would have minor impact on this species. Direct impacts to designated critical habitat would not be anticipated as dredging operations for all projects would not encroach upon beach areas or either of the two Islands. Beneficial use of dredge material may cause temporary displacement of specific individuals but could result in the creation of additional suitable habitat for the piping plover.

4.20.5.15 Terrestrial Mammals

The proposed project will have no direct impacts upon terrestrial mammal communities in the study area. However, past and future actions are subject to regulatory authority by the USACE and any

impacts and/or losses to these communities would be mitigated. Thus no significant cumulative impact is anticipated.

4.20.5.16 Water Quality

One of the cumulative impacts associated with the listed projects is short-term water quality degradation in the general vicinity of dredging operations and permanent changes to water quality in bottom habitats with increased depths. Dredging operations will result in temporary and localized water quality degradation, altering turbidity, conductivity, dissolved oxygen, and temperature regimes. More permanent changes are anticipated to occur where either a new channel or existing channel is widened to depths of 13.8 feet or greater. Channels deeper than 13.8 feet have been observed to have dissolved oxygen levels below the 4 mg/L State Standard and areas deeper than 19.2 feet are hypoxic (dissolved oxygen levels less than 2 mg/L), consistent with conditions in the existing Pascagoula Harbor Navigation Channel. Because water quality alterations from dredging operations are temporary and localized and the actual acreage of bottom habitat that might be permanently altered is small, in comparison to the overall size of the Mississippi Sound, cumulative impacts would be less than significant. No protected or commercially viable species, loss of unique or important habitat would result from these water quality alterations.

4.20.5.17 Commercial and Recreational Fishing

None of the proposed or ongoing projects are anticipated to impact commercial or recreational fisheries in the study area. While many of the proposed and current projects involve dredging operations resulting in increased turbidity levels and degradation of water quality these impacts will be temporary and fish and prey populations will quickly return to pre-construction conditions.

4.20.5.18 Essential Fish Habitat

Similarly, dredging operations would temporarily reduce the quality of EFH in the vicinity of any of the proposed actions. Meanwhile some actions may permanently convert shallow, primarily silt and clay soft bottom habitats to deeper habitat reducing the functionality and ability of this natural system type to support federally managed species. For example, the proposed action would convert approximately 87.6 acres of shallow bottom habitat to deeper bottom habitat. While the overall cumulative conversion of habitat type may be judged as minor compared to the entire Mississippi Sound and the converted area does not included any seagrasses, the habitat conversion does represent a net loss of a more productive habitat (when compared with deeper, dredged channel bottom). Fish and shellfish species would temporarily shift feeding habitats during dredging operations to undisturbed areas until dredging and/or construction activities have been suspended and habitat recovery has occurred, thus the cumulative impacts would be temporary in nature. Dredged material placement for any of the listed actions is not anticipated to cause any long-term contamination problems for EFH.

4.20.5.19 Socio-Economics

The listed projects are compatible with the economic goals of the Port of Pascagoula and would result in increased employment (more than 200 permanent jobs) and stimulation of the local economy. This is particularly important for an area still recovering from the aftermath of Hurricane Katrina and the Deepwater Horizon oil spill. Temporary employment opportunities would be created during construction of the MS Integrated Gasification Combined Cycle Facility, and Chevron PBOP. Temporary jobs would also be created by the projects requiring dredging. No environmental justice impacts are known to be associated with any of the channel improvement or maintenance dredging projects.

4.20.5.20 Navigation and Ports

Dredging (including maintenance dredging) associated with the proposed project and other listed projects may cause delays in shipping, but these delays would be temporary. Listed projects could also result in increased shipping traffic as vessels travel to and from the project facilities and add to the amount of cargo managed by port facilities. The cumulative impact of these actions may be a temporary delay in shipping during dredging operations and increased ship traffic and cargo managed by port facilities after listed projects have been implemented; potential impacts would be reduced due to an overall increase in port operational efficiencies.

4.20.6 Conclusions

Cumulative impacts due to past, current, and reasonably foreseeable future projects (1–3 years), in combination with the proposed project, are not anticipated to have significant adverse impacts to the environmental resources within the project area. The majority of environmental impacts associated with the projects described in Sections 4.20.3 and 4.20.4 will be temporary, and in most cases result in beneficial impacts to the region. One of the long-term cumulative impacts associated with the listed projects will be increased economic opportunity in terms of the number of jobs created and stimulus to the local economy.

Several of the projects included in the cumulative impact analysis involve dredging, some involving maintenance dredging, which result in temporary impacts such as increased turbidity, air emissions and long-term impacts to the harbor bottom. Widening of existing channels to depths of 19.2 feet or greater (i.e., to depth of existing channel, –42 feet MLLW) would convert shallow silty clay bottom habitat to less productive deeper habitat that most likely will be hypoxic with dissolved oxygen levels below 2 mg/L. Dredging associated with the evaluated projects may result in adverse water quality and sediment conditions because of low concentrations of some contaminants already in shipping channel sediments, but are not anticipated to be toxic to aquatic organisms.

The proposed project has the potential to adversely impact a previously recorded cultural resource that has been determined eligible for listing in the NRHP and will require mitigation as well as ongoing coordination with the USACE, MDAH, and any interested federally recognized tribes. Because current conditions would continue to adversely affect a previously recorded cultural resource, even dredging operations associated with listed projects that would primarily occur in previously disturbed areas may have cumulative impacts on cultural resources unless mitigation occurs prior to future dredging operations. Construction of new facilities and pipelines associated with the listed projects may also impact the resource, requiring coordination with the appropriate regulatory agencies, including the USACE and MDAH, as appropriate, and action taken as directed.

Existing governmental regulations will address the issues which influence local and ecosystem-level conditions. Natural resources in the area are provided protection through coordination with stakeholder groups, local organizations, and state and Federal regulatory agencies implementing regulations such as the CWA and the CAA (Section 5). This collaboration and regulation of impacted resources should prevent or minimize negative impacts which could threaten the health and sustainability of the region.

5 COMPLIANCE WITH ENVIRONMENTAL REGULATIONS

5.1 Introduction

This section provides an overview of laws and regulations associated with dredging improvements of the Federal project at Pascagoula Harbor (i.e. Bayou Casotte and Lower Pascagoula Channels) and subsequent disposal of that dredged material in approved disposal site(s), and the future O&M (i.e. dredging and material disposal) of that improved navigational feature. In addition, this section provides a summary and documentation of compliance with these regulations.

5.2 Clean Water Act

The Federal Water Pollution Control Act of 1972, as amended, commonly called the CWA, authorizes the USEPA to regulate activities resulting in a discharge to navigable waters. Section 401 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 water quality standards. Section 401 water quality certification is obtained from the applicable state (Mississippi in this case). Pursuant to Section 401 of the Federal Water Pollution Control Act of 1972, the USACE, Mobile District requested water quality certification from the MDEQ, OPC for the Proposed Action on September 3, 2014 and concurrence is anticipated after publication of the FEIS (see Appendix C). This water quality certification includes both improvement construction, to be undertaken by the non-Federal sponsor, JCPA, and the future O&M of that improved navigation project by the Federal government, the USACE, Mobile District, during its routine maintenance operations.

Section 402 established the NPDES, which regulates discharges into waters of the U.S. The USEPA, Region 4 has jurisdiction in the Southeast, including Mississippi. The USEPA may delegate portions of its regulatory authority to individual states. On January 8, 1998, the USEPA issued a Notice of Revised Draft NPDES General Permit Re-issuance to the states of Mississippi, Alabama, and Florida for activities under their jurisdiction. No upland disposal sites are to be constructed with this proposed action; therefore, the USACE, Mobile District will not need to request a NPDES certification from the MDEQ.

Section 404 of the CWA normally requires a USACE permit for the discharge or deposition of dredged or fill material and for the building of structures in all waters of the U.S. As a matter of policy the USACE does not issue itself permits under any of the regulatory authorities it administers - Sections 9 and 10 of the 1899 Rivers and Harbors Act, Section 404 of the CWA and Section 103 of the MPRSA. Criteria to be considered in evaluating the alternatives include cost, technology, environmental effects, and logistics. Guidelines prepared for the evaluation of dredged and fill material also indicate that actions subject to the NEPA would, in all probability, meet the requirements of the analysis of alternatives specified by Section 404(b)(1) guidelines. As part of its review, the USACE consults with other agencies, including the USFWS and the SHPO. A Section 404(b)(1) evaluation report has been prepared and is included (*Appendix H – Section 404 (b)(1) Evaluation*).

5.3 Water Resources Development Act

Improvements to the Pascagoula Harbor Navigation Channel were completed in 1965 and first authorized by the River and Harbor Acts of March 1913, March 1915, May 1950, September 1954,

July 1958, July 1960, and October 1962. However, Section 202(a) of WRDA 1986 (PL 99-962) and subsequent harbor documents provided for additional modifications to the Federal navigation project at Pascagoula Harbor. The WRDA contains an environmental protection mission, codified at 33 U.S.C. § 2316, which states, "that the Secretary shall include environmental protection as one of the primary missions of the Corps of Engineers in planning, designing, constructing, operating, and maintaining water resources projects."

This FEIS documents compliance with the provisions of the WRDA environmental protection mission in Sections 2, 3, 4, and 5.

5.4 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 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. Permission to install a feature or conduct dredging or filling requires the approval of the Chief of Engineers. Improvements to the Pascagoula Harbor Navigation Channel was completed in 1965 and first authorized by the River and Harbor Acts of March 1913, March 1915, May 1950, September 1954, July 1958, July 1960, and October 1962.

This FEIS has been prepared by the USACE, Mobile District.

5.5 National Environmental Policy Act

NEPA requires that all Federal agencies use a systematic, interdisciplinary approach to protect the human 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.

NEPA excuses or excludes a Federal agency from the preparation of any formal environmental analysis with respect to actions that result in minor or no environmental effects, which are known as "categorical exclusions." An intermediate level of analysis, an Environmental Assessment (EA), is prepared for an action that is not clearly categorically excluded, but does not clearly require an EIS [40 CFR § 1501.3 (a) and (b)]. Based on the EA, the Federal agency either prepares an EIS, if one appears warranted, or issues a "Finding of No Significant Impact" (FONSI), which satisfies the NEPA requirement.

NEPA also requires the preparation of an EIS for any major Federal action that could have a significant impact on the environment. The EIS must address any adverse environmental effects that cannot be avoided or mitigated, alternatives to the Proposed Action, the relationship between short-term resources and long-term productivity, and irreversible and irretrievable commitments of resources. According to 40 CFR § 1502.9, a supplement to either a DEIS or FEIS must be prepared if an agency makes substantial changes in the Proposed Action that are relevant to environmental concerns, or there are significant new circumstances or information relevant to environmental concerns and bearing on the Proposed Action or its impacts.

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 human 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.

A FEIS has been prepared to address potential socioeconomic and environmental impacts associated with the proposed improvements and future O&M to the Pascagoula Harbor's Bayou Casotte and Lower Pascagoula Channels.

5.6 Marine Protection, Research and Sanctuaries Act

Congress declared that ocean dumping in the territorial seas or the contiguous zone of the U.S. would be regulated under the MPRSA of 1972 (33 U.S.C. § 1401 et seq.). The authority to establish criteria for evaluating proposed ocean disposal of dredged and non-dredged materials is identified in 40 CFR § 228.1, pursuant to Section 103 of the MPRSA. The program is designed to prevent unreasonable degradation of the marine environment from all materials being disposed of into the ocean. On December 31, 1981, 33 U.S.C. § 1412a mandated the termination of ocean dumping of sewage sludge and industrial wastes. The EISs for these disposal sites describe impacts that are expected to occur over a period of 25 years. Under 33 U.S.C. § 1413 (33 CFR § 324), the USACE issues permits to transport dredged and non-dredged materials for the purpose of disposing of them in ocean waters. For USACE conducted federally authorized navigation projects *(i.e. Civil Works)* which do not have a permit document, Section 103(e) of the MPRSA provides that USACE may in lieu of permit procedures, issue regulations (33 CFR § 335 through 338) for federally authorized navigation projects. Regulations provide for *inclusion of appropriate conditions in the construction contract specifications for environmental compliance*. Section 104(a) and 103(c) of MPRSA provide authority for conditioning of permits.

This FEIS has been coordinated with appropriate state and Federal agencies in accordance with the MPRSA and includes an evaluation of the Proposed Action's potential impacts to resources protected under this act (*Appendices C and I*).

5.7 National Marine Sanctuaries Act

The National Marine Sanctuary and NERR Programs are administered by the Sanctuaries and Reserves Division, National Ocean Service, NOAA, of the U.S. Department of Commerce (USDOC). The National Marine Sanctuary Program was established by the MPRSA (33 U.S.C. § 1401-145), and the NERR Program was established by the CZMA of 1972.

The National Marine Sanctuaries Act, or Title III of the MPRSA, allows the Secretary of Commerce to designate any discrete area of the marine environment as a National Marine Sanctuary if the Secretary finds the following:

- The marine site is of special national significance due to its conservation, recreational, ecological, historical, scientific, cultural, archaeological, educational, or aesthetic qualities; the communities of living marine resources it harbors; or its resource or human-use values.
- Existing state and Federal authorities are inadequate or should be supplemented to ensure coordinated and comprehensive conservation and management of the area, including resource protection, scientific research, and public education, and designation as a National Marine Sanctuary will facilitate these objectives, and
- The area is of a size and nature that will permit comprehensive and coordinated conservation and management.

The National Marine Sanctuary Act stipulates that if a Federal action is likely to destroy, cause the loss of, or injure a sanctuary resource, the Secretary must recommend reasonable and prudent alternatives that can be used by the agency, in implementing the action that will protect sanctuary resources.

No National Marine Sanctuaries are located near the Pascagoula Harbor. There is, however, one National Marine Reserve, Grand Bay Reserve, located approximately 2.5 to 3 miles east of the project study area. Due to the distance from the project study area, it is not likely that the Proposed Action would adversely impact the marine reserve (NOAA, 2007f).

5.8 Fishery Conservation and Management Act

The Fishery Conservation and Management Act of 1976 (16 U.S.C. § 1801 et seq.) established the following (NMFS, 1976):

- A fishery conservation zone between the territorial seas of the U.S. and 200 nm 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 (Pub. L. 104-297, October 11, 1996), to address the substantially reduced fish stocks, which had declined as a result of direct and indirect habitat loss. The act was renamed the MSFCMA (Pub. L. 94-265, October 11, 1996), as amended. This act provides for the conservation and management of the fisheries, and the identification and protection of EFH (NMFS, 1996).

Potential impacts on fish species and associated essential habitats have been evaluated in this FEIS in Section 4. In accordance with the NMFS, HCD, EFH conservation recommendations and the MSFCMA, the USACE has prepared a comprehensive EFH assessment for the proposed action of the Pascagoula Harbor's Bayou Casotte and Lower Pascagoula Channels. The USACE has provided this comprehensive EFH assessment to NMFS, HCD to ensure full review of potential impacts on the habitat and species found in the EFH. Concurrence from NMFS, HCD was requested on September 3, 2014 and concurrence was received on October 30, 2014 (see Appendix C and I).

5.9 Endangered Species Act

The ESA of 1973 (16 U.S.C. § 1531-1543), as amended, establishes a national policy designed to protect and conserve T&E species and the ecosystems upon which they depend. The ESA is administered by the USDOI, through the USFWS, and by the USDOC, through the NMFS, PRD. 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 Section 7(a)(2)) must participate in the interagency cooperation and consultation process.

The Proposed Action has been reviewed by the USFWS and the NMFS, PRD, if applicable, to determine compliance with the ESA. The USACE, Mobile District received a final concurrence letter on August 20, 2014 with a determination that the proposed action "may affect, but is not likely to adversely affect West Indian manatee" (See Appendix C). Coordination with NMFS, PRD was concluded on November 4, 2015 with the receipt of a BiOp, stating the proposed action would be covered under the GRBO.

Potential project impacts to T&E species have been fully evaluated in this FEIS and in a Biological Assessment (included in Appendix C) prepared by the USACE, Mobile District. In accordance with Section 7 of the ESA, these assessments have been coordinated with the USFWS and the NMFS, PRD.

5.10 Fish and Wildlife Coordination Act of 1934 (FWCA)

The FWCA, as amended, requires consultation and coordination with the USFWS and state fish and wildlife agencies, where "waters of any stream or other body of water are proposed or authorized, permitted or licensed to be impounded, diverted… or otherwise controlled or modified" by an agency under Federal permit or license (16 CFR § 661-667e). The USACE generally requests a letter from the USFWS for new work dredging projects. The USFWS letter identifies fish and wildlife resources that may be impacted by the dredging and disposal operations, and identifies T&E species within the general area of dredging and disposal operations.

This FEIS has evaluated impacts of the Proposed Action to fish and wildlife as described in Section 4. The USACE, Mobile District has coordinated the proposed action with the USFWS (*Appendix J – USFWS Coordination*). The USFWS has provided its Planning Aid Assistance letter dated November 9, 2012. The USFWS has also provided its FWCA Report dated May 6, 2013.

5.11 National Historic Preservation Act

The NHPA, enacted in 1966 and amended in 1970 and 1980, provides for a 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 U.S. According to EO 11593, Protection and Enhancement of the Cultural Environment (3 CFR § 1971 – 1975, May 13, 1971), 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.

Archival research and consultation with the SHPO in accordance with the NHPA, as amended, the Archeological and Historic Preservation Act, as amended, and EO 11593 have been conducted. This EIS addresses the process to assure compliance with the provisions of the NHPA. Impacts to cultural and historical resources are discussed in Section 4.0. The Proposed Action has followed USACE Section 404 permit application process and sought SHPO review of archaeological and historical resources and concurrence prior to operations. This FEIS addresses the proposed action to assure compliance with the provisions of this act. The USACE, Mobile District has consulted with interested federally recognized tribes, ACHP, MDAH on the Proposed Action and received concurrence from the SHPO on April 28, 2017 (Appendix C and F). As of the publication date of this document, no tribes have commented on this project.

5.12 Coastal Zone Management Act

The 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, direct and indirect 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 (Pub. 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 (OCRM), within the NOAA National Ocean Service (MMS, 1999).

NOAA approved the Mississippi Coastal Program in 1980. The MDMR is the lead agency, and the Mississippi Coastal Program resolves conflicts over local coastal uses. The authority guiding the Mississippi Coastal Program 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, which incorporates stakeholder interests in coastal development issues in Mississippi (NOAA, 2003).

This FEIS has evaluated impacts of the Proposed Action to coastal resources as described in Section 4. The USACE, Mobile District has made a determination that the Proposed Action is consistent with the state's federally approved coastal management program to the maximum extent practicable. The USACE, Mobile District requested CZC on September 3, 2014 from the MDMR and a Coastal Zone Consistency Determination was received on November 5, 2014 (see Appendix C).

5.13 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 NMFS, PRD. 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 (MMS, 1999).

Potential impacts to marine mammals resulting from the Proposed Action and measures to offset the potential impacts are considered in Section 4. Incorporation of the safeguards used to protect T&E species during project implementation would also protect any marine mammals in the area; therefore, the USACE, Mobile District has coordinated with the USFWS and NMFS, PRD for concurrence that the project complies with this Act. The USACE, Mobile District received final concurrence from USFWS on August 20, 2014 and from NMFS, PRD on November 4, 2015.

5.14 EO 12898 – Environmental Justice Policy

The Environmental Justice Policy, based on EO 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. Environmental Justice 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. Fair treatment means that no group of people, including racial, ethnic, or socioeconomic group, should bear a disproportionate share of the negative environmental

consequences resulting from industrial, municipal, and commercial operations or the execution of Federal, state, local, and tribal programs and policies."

The effects of the Proposed Action on local populations and the resources used by local groups, including minority and low-income groups, are addressed in Section 4. The Proposed Action complies with EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and does not represent disproportionately high and adverse human health or environmental effects on minority populations and low-income populations in the U.S. The proposed area is not used disproportionately by these populations.

5.15 EO 13045 – Protection of Children

On April 21, 1997, President Clinton issued EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks*. This EO 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. These risks arise because:

- Children's neurological, immunological, digestive, and other bodily systems are still developing;
- Children eat more food, drink more fluids, and breathe more air in proportion to their body weight than adults;
- Children's size and weight might diminish their protection from standard safety features; and
- Children's behavior patterns make them more susceptible to accidents because they are less able to protect themselves.

Therefore, to the extent permitted by law, and appropriate and consistent with each agency's mission, the President directed each Federal agency to:

- Make it a high priority to identify and assess environmental health risks and safety risks that might disproportionately affect children; and
- Ensure that the agency's policies, programs, and standards address disproportionate health risks to children that result from environmental health risks or safety risks.

Examples of risks to children include increased traffic volumes and industrial or production-oriented activities that would generate substances or pollutants that children might come into contact with or ingest.

The potential environmental health or safety risks to children resulting from the Proposed Action are addressed in Section 4. The Proposed Action complies with EO 13045, *Protection of Children from Environmental Health Risks and Safety Risks,* and does not represent disproportionately high and adverse environmental health or safety risks to children in the U.S. The proposed area is not used disproportionately by children.

5.16 Ports and Waterways Safety Act

The PWSA (86 Stat. 424, Pub. L. 92-340, July 10, 1072) is designed to promote navigation, vessel safety, and protection of the marine environment. The PWSA applies in any port or place under the jurisdiction of the U.S. The PWSA requires the USCG to promulgate regulations regarding "design, construction, alteration, repair, maintenance, operation, equipping, personnel qualifications, and manning of vessels necessary for the increased protection against hazards to life and property, for navigation and vessel safety, and for enhanced protection of the marine environment" (MMS, 2004b).

The PWSA was amended by the Port and Tanker Safety Act of 1978 (33 U.S.C. § 122, Pub L. 95-474 October 17, 1978). Under this amendment, Congress found that navigation and vessel safety and protection of the marine environment are matters of major national importance and that increased vessel traffic in the nation's ports and waterways creates substantial hazard to life, property, or the marine environment (MMS, 2004b).

Section 4 includes an evaluation of potential impacts of the Proposed Action on socioeconomics and the marine environment. Channel widening and future O&M of that improved navigation project would facilitate vessel traffic and reduce delays by allowing two-way traffic patterns in the channel.

5.17 State of Mississippi Regulatory Programs

Several of the regulatory programs above occur through explicit partnership with and/or implementation by State of Mississippi agencies. In Mississippi, the Mississippi Coastal Program oversees coastal development projects. These include the CAA (delegated to MDEQ), CWA (via joint MDMR/USACE coastal wetlands permit and MDEQ water quality certification), Magnuson-Steven Act, NHPA, NEPA, FWCA, Estuary Protection Act, AFCA, and FPPA, as described above in the summaries of each of these regulatory programs.

In Mississippi, the Mississippi Coastal Program oversees coastal development projects. In addition, there are several policies regarding dredging of harbors/channels and disposal of dredged material. A joint MDMR/USACE coastal wetlands permit and a MDEQ water quality certification are required for all dredging and filling projects. Agency review and coordination procedures are discussed in Chapter 8 of the Rules, Regulations, Guidelines, and Procedures of the 1988 Mississippi Coastal Program. The MDMR is currently coordinating with the USACE to develop a comprehensive dredged material management plan for maintenance dredging and beach nourishment programs in coastal waters. The proposed action includes the improvements by the non-Federal sponsor, JCPA, and the subsequent future O&M by the USACE, Mobile District.

Mississippi guidelines include the following related to dredged material disposal:

- Permanent dredged material disposal sites shall be designated for initial construction as well as future maintenance dredging for all canal or channel projects.
- All dredged material shall be viewed as a potential reusable resource and materials suitable for beach nourishment, construction, or other purposes shall be used immediately for such purposes or stockpiled in existing disposal areas or other non-wetland areas for later use.
- Existing upland disposal areas shall be used to the fullest extent possible.
- Permanent, upland disposal sites or deepwater disposal sites shall be used in preference to coastal wetland disposal.
- Areas containing SAVs or regularly flooded emergent vegetation shall not be used for dredged material disposal.
- New dredged material proposals shall include a maintenance plan for the shorter of 50 years or the life of the project.

5.17.1 Coastal Wetlands Protection Act (Wetlands Act) (Miss. Code Ann. § 49-27)

The Wetlands Act is intended to “favor the preservation of the natural state of the coastal wetlands and their ecosystems and to prevent the despoliation and destruction of them, except where a specific

alteration of specific coastal wetlands would serve a higher public interest in compliance with the public purposes of the public trust in which coastal wetlands are held."

The Wetlands Act requires a permit from the MDMR to affect any coastal wetlands unless excluded. Regulatory considerations for the dredging of new channels include the benefit of such channel to the public at large, or to surrounding landowners, and the extent of use projected for the channel, as well as the ecological, economic, commercial, recreational and aesthetic value of the wetlands affected.

The Wetlands Act requires participation in the MDMR's Beneficial Use Program for any project permitted (excludes Federal Civil Works projects) to remove more than 2,500 cys of material from coastal wetlands, if the material is suitable and a beneficial use site is available. In exchange for participating in the Beneficial Use Program, the MDMR reduces the fees typically charged for removal of materials from wetlands.

5.17.2 Public Trust Tidelands Law (Miss. Code Ann. § 29-15)

The Public Trust Tidelands Law is executed by the State of Mississippi as public policy "to favor the preservation of the natural state of the public trust tidelands and their ecosystems and to prevent the despoliation and destruction of them, except where a specific alteration of specific public trust tidelands would serve a higher public interest in compliance with the public purposes of the public trust in which such tidelands are held." This policy is implemented in part through the regulatory provisions of the Wetlands Act, and in part through the authorization of leases of state public trust tidelands or submerged lands.

This FEIS has been prepared and navigational servitude will be implemented for the future O&M of the improved project. For the improvements to be undertaken by JCPA, an EIS was prepared in coordination with USACE, Regulatory Division for consistency with the above State of Mississippi policies and guidelines, where appropriate.

5.18 Clean Air Act

Although the 1990 CAA is a Federal law covering the entire country, 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 U.S. This promotes uniformity in basic health and environmental protections. 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. (MMS, 1999).

States must develop State Implementation Plans (SIPs) that explain how each state will do its job under the CAA. A SIP is a collection of the regulations a state will use to clean up areas that exceed applicable air quality standards.

The potential air quality impacts resulting from this project are discussed in Section 4. No air quality permits are required for this project.

5.19 Wild and Scenic River Act Of 1968

Wild and Scenic Rivers Act (16 U.S.C. § 1271-1287, Pub. L. 90-542, October 2, 1968) establishes a National Wild and Scenic Rivers System and prescribes the methods and standards through which additional rivers may be identified and added to the system. The Act authorized the Secretary of the Interior and the Secretary of Agriculture to study areas and submit proposals to the President and Congress for addition to the system. It describes procedures and limitations for control of lands in

federally administered components of the system and for dealing with disposition of lands and minerals under Federal ownership. Rivers are classified as wild, scenic or recreational, and hunting and fishing are permitted in components of the system under applicable Federal and State laws.

The FEIS has evaluated impacts of the Proposed Action to these resources as described in Section 4. No systems have been identified within the proposed area.

5.20 Estuary Protection Act Of 1968

The Estuary Protection Act (16 U.S.C. § 1221-1226; Pub L. 90-454, 82 Stat. 625 August 3, 1968), highlighted the values of estuaries and the need to conserve their natural resources. It authorized the Secretary of the Interior, in cooperation with other Federal agencies and the States, to study and inventory estuaries of the U.S., including land and water of the Great Lakes, and to determine whether such areas should be acquired by the Federal Government for protection. This report to Congress was required by January 30, 1970. This statute also authorized the Secretary of the Interior to enter into cost-sharing agreements with States and subdivisions for permanent management of estuarine areas in their possession. Federal agencies were required to assess the impacts of commercial and industrial developments on estuaries. Reports submitted to Congress for such projects were required to contain an assessment by the Secretary of the Interior of likely impacts and related recommendations. The Secretary was also required to encourage State and local governments to consider the importance of estuaries in their planning activities related to Federal natural resource grants. In approving any state grants for acquisition of estuaries, the Secretary was required to establish conditions to ensure the permanent protection of estuaries, including a condition that the lands not be disposed of without the prior approval of the Secretary.

This FEIS has evaluated impacts of the Proposed Action to these resources as described in Section 4. This EIS evaluates potential impacts to estuaries as described in Section 4. The Department of Interior and other Federal and state agencies are included in the distribution of this EIS, as provided in the Estuary Protection Act.

5.21 Resources Conservation and Recovery Act

RCRA (42 U.S.C. § 6901 et seq) provides for comprehensive ‘cradle-to-grave’ regulation of hazardous waste and authorizes environmental agencies to order the cleanup of contaminated sites. Since 1984, it has also called for the extensive regulation of underground storage tanks and the cleanup of contamination caused by leaking tanks. In addition, the Act addresses the environmental problems associated with nonhazardous solid waste and encourages states to develop solid waste management programs, regulate solid waste landfills and eliminate open dumps. Federal facilities are required to comply with Federal, state and local regulations and requirements on solid and hazardous waste and underground storage tanks to the same extent as private parties. RCRA contains provisions on a number of other topics, such as resource recovery, used oil management and recycling, small town environmental planning and plastic ring carriers. While most of the RCRA's provisions focus on the protection of human health, its wide-ranging attempts to prevent, reduce and eliminate pollution have an obvious, if largely unstated, effect on wildlife protection as well.

No RCRA activities are associated with the Proposed Action described in this Final EIS.

5.22 Toxic Substances Control Act

The TSCA (Pub. L. 94-469, January 1, 1977) was enacted by Congress to give USEPA the ability to track the 75,000 industrial chemicals currently produced or imported into the U.S. The USEPA repeatedly screens these chemicals and can require reporting or testing of those that may pose an environmental or human-health hazard. The USEPA can ban the manufacture and import of those chemicals that pose an unreasonable risk. Also, USEPA has mechanisms in place to track the thousands of new chemicals that industry develops each year with either unknown or dangerous characteristics. The USEPA then can control these chemicals as necessary to protect human health and the environment. TSCA supplements other Federal statutes, including the CAA and the Toxic Release Inventory.

No TSCA activities are associated with the Proposed Action described in this FEIS.

5.23 Coastal Barrier Resources Act

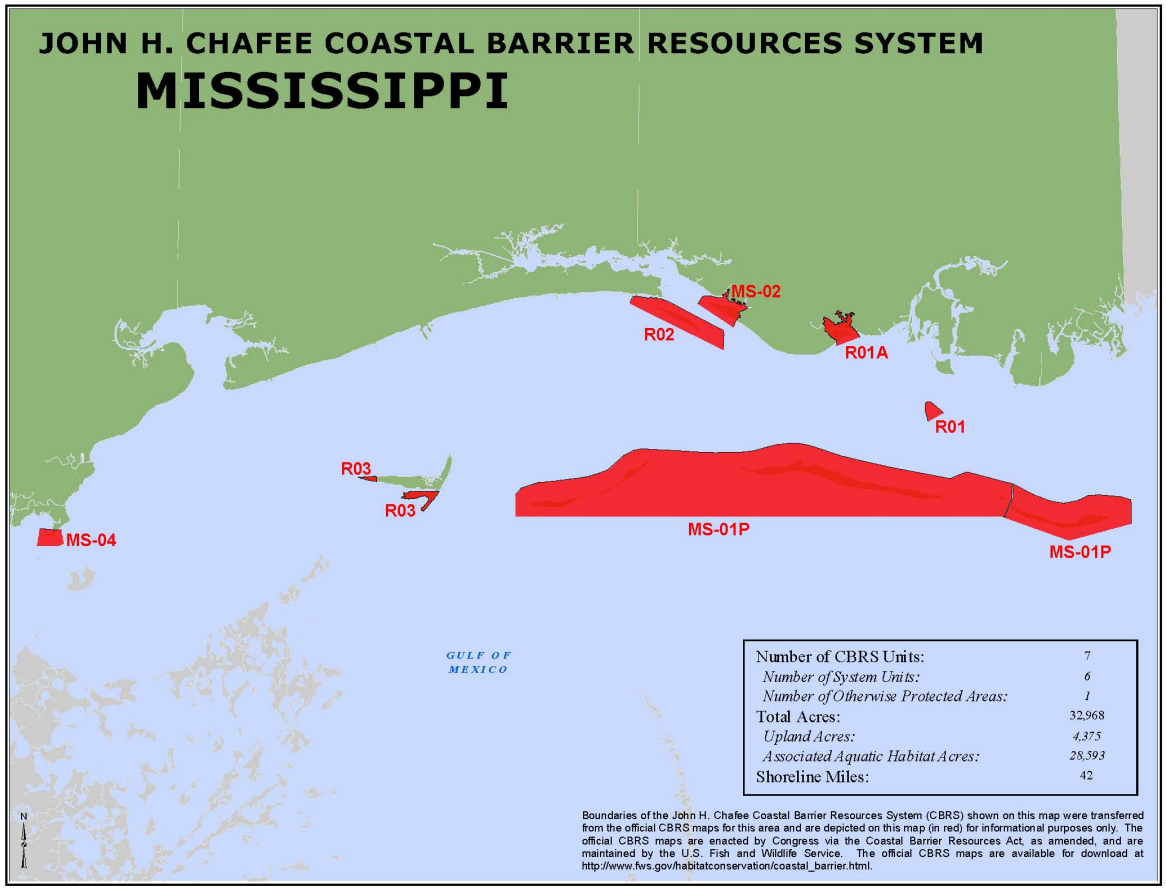
CBRA, Pub. L. 97-348 (96 Stat. 1653; 16 U.S.C. § 3501 et seq.), enacted October 18, 1982, designated various undeveloped coastal barrier islands, depicted by specific maps, for inclusion in the CBRA. Areas so designated were made ineligible for direct or indirect Federal financial assistance that might support development, including flood insurance, except for emergency life-saving activities. Exceptions for certain activities, such as fish and wildlife research, are provided, and National Wildlife Refuges and other, otherwise protected areas are excluded from the CRBA.

Within the State of Mississippi, CBRA units are designated as Gulf Islands (MS-01P), Heron Bay Point (MS-04), Round Island (R01), Belle Fontaine Point (R01A), Deer Island; Marsh Point (R02, MS-02), and Cat Island (R03) (Figure 5.25-1). Of those CBRA units, Round Island and Gulf Islands are located within the project vicinity. However, A Federal expenditure is allowable within the CBRS, if it meets any of the following exceptions (16 U.S.C. § 3505(a)(1)-(5)):

- The maintenance or construction of improvements of existing Federal navigation channels (including the Intracoastal Waterway) and related structures (such as jetties), including the disposal of dredge materials related to such maintenance or construction. A Federal navigation channel or a related structure is an existing channel or structure, respectively, if it was authorized before the date on which the relevant System unit or portion of the System unit was included within the CBRS.

The proposed action would be constructed and the future O&M activities would be conducted in compliance with CBRA.

Figure 5.25-1 ***Mississippi***
Coaster Barrier Resources System Area Units



5.24 EO 11988, Floodplain Management

EO 11988 (3 CFR § 1977, 42 Fed. Reg. 26951 May 24, 1977) requires Federal agencies to avoid to the extent possible the long- and short-term adverse impacts associated with the occupancy and modification of floodplains and to avoid direct and indirect support of floodplain development wherever there is a practicable alternative. In accomplishing this objective, "each agency shall provide leadership and shall 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 its responsibilities" for the following actions:

- acquiring, managing, and disposing of Federal lands and facilities;
- providing federally-undertaken, financed, or assisted construction and improvements; and
- conducting Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

The USACE will ensure that the Proposed Action evaluated in this FEIS fully complies with this EO.

5.25 EO 11990, Protection of Wetlands

The purpose of EO 11990 (42 Fed. Reg. 26961, May 24, 1977) is to "minimize the destruction, loss or degradation of wetlands and to preserve and enhance the natural and beneficial values of wetlands." To meet these objectives, this EO requires Federal agencies, in planning their actions, to consider alternatives to wetland sites and limit potential damage if an activity affecting a wetland cannot be avoided. The EO applies to:

- Acquisition, management, and disposition of Federal lands and facilities construction and improvement projects which are undertaken, financed or assisted by Federal agencies; and
- Federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulation, and licensing activities.

Effects on wetlands are discussed in Section 4 and will be considered during the review of all certifications required under the CWA.

5.26 EO 13186, Protection of Migratory Birds

EO 13186 (Fed. Reg. Vol. 66, No. 11, January 10, 2001), directs each Federal agency taking actions that are likely to have a measureable effect on migratory bird populations to develop and implement a Memorandum of Understanding (MOU) with the USFWS that shall promote the conservation of migratory bird populations. Potential effects on fish and wildlife, including migratory birds, are discussed in Section 4 of this EIS and have been coordinated with the USFWS.

5.27 Anadromous Fish Conservation Act

The Anadromous Fish Conservation Act (16 U.S.C. § 757a-757g, Pub. L. 89-304, as amended) authorizes the Secretary of Commerce, along with the Secretary of Interior, or both, to enter into cooperative agreements to protect anadromous and Great Lakes fishery resources.

Although the term "anadromous" refers only to those fish that spawn in freshwater and live most of their lives in saltwater, it is often used interchangeably with "diadromous." The term "diadromous" refers to any fish that migrate between saltwater and freshwater. Examples of fish affected by this law are salmon and Atlantic striped bass.

Implementation of this Anadromous Fish Conservation Act occurs through the NMFS within the USDOC and through the USFWS within the USDOI. To conserve, develop, and enhance anadromous fisheries, the fisheries which the U.S. has agreed to conserve through international agreements, and the fisheries of the Great Lakes and Lake Champlain, the Secretary may enter into agreements with States and other non-Federal interests. An agreement must specify:

- the actions to be taken;
- the benefits expected;
- the estimated costs;
- the cost distribution between the involved parties;
- the term of the agreement;
- the terms and conditions for disposal of property acquired by the Secretary; and
- any other pertinent terms and conditions.

Pursuant to the agreements authorized under the Act, the Secretary may:

- conduct investigations, engineering and biological surveys, and research;
- carry out stream clearance activities;
- undertake actions to facilitate the fishery resources and their free migration;
- use fish hatcheries to accomplish the purposes of this Act;
- study and make recommendations regarding the development and management of streams and other bodies of water consistent with the intent of the Act;
- acquire lands or interest therein;
- accept donations to be used for acquiring or managing lands or interests therein; and
- administer such lands or interest therein in a manner consistent with the intent of this Act.

Following the collection of these data, the Secretary makes recommendations pertaining to the elimination or reduction of polluting substances detrimental to fish and wildlife in interstate or navigable waterways. Joint NMFS and USFWS regulations applicable to this program are published in 50 CFR Part 401.

Discussion of potential effects on fish and wildlife, including anadromous fish, is contained in Section 4. These effects have been reviewed by NMFS in accordance with the Anadromous Fish Conservation Act.

5.28 EO 11593, Protection and Enhancement of Cultural Resources

The Federal Government shall provide leadership in preserving, restoring and maintaining the historic and cultural environment of the Nation. Federal agencies shall (1) administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations, (2) initiate measures necessary to direct their policies, plans and programs in such a way that federally owned sites, structures, and objects of historical, architectural or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people, and (3), in consultation with the ACHP (16 U.S.C. § 470i), institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures and objects of historical, architectural or archaeological significance.

Archival research and consultation with the SHPO has been conducted in accordance with the NHPA, as amended, the Archeological and Historic Preservation Act, as amended, and EO 11593.

5.29 Compliance with Section 408

Should the Section 204(f) project be approved by the Secretary, the USACE must determine that the proposed modification does not impair the usefulness of the Federal project and is not injurious to the public interest. The JCPA will submit a written request to the Mobile District for a Section 408 permit. Analyses performed for this study and documented within this report address documentation requirements for both Section 204(f) and Section 408.

As identified in EC 1165-2-216, dated 30 October 2013, documentation specifically required for the District to make a determination for a deep draft navigation project include the following. Report sections/appendices that provide this information are provided.

- Technical Analysis and Design. Technical analysis and design must be at a minimum 60 percent complete. This information is contained in summary format in Main Report Section 5.2, with the detailed analysis provided in Appendix A, Engineering.

- System Performance Analysis. The purpose of the system performance analysis is to determine the potential upstream and downstream hydrologic and hydraulic impacts of proposed modifications. Although typically applied to projects addressing reservoir operations, bridge constructions, etc., a system performance analysis may also be appropriate for alterations to deep draft navigation projects as changes in channel design can impact the surrounding area. Analyses addressing system performance are contained in summary format in Main Report Sections 3.3 and 3.4, with the detailed analyses provided in Appendix A, Engineering, Appendix F, Field Data Collection and Modeling, and the FEIS.

- Environmental Compliance. Environmental compliance is documented in summary format in Main Report Sections 2.4, 2.5, 2.6, 3.3, 4.2, and 5.3. The detailed evaluation and documentation is provided in the FEIS.

- Real Estate Requirements. A list of the real property rights needed to support the proposed modification must be provided and include those owned by the applicant and/or those needed to be acquired. Real Estate requirements for the proposed project are documented in summary format in Main Report Section 5.4, with details of the evaluation contained within Appendix D, Real Estate Plan.

- Applicant Review Plans. Review plans developed for the Section 204(f) study serve to satisfy requirements for it as well as Section 408 deliverables.

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7 REFERENCES

Abele, L.G. and W. Kim. 1986. An Illustrated Guide to the Marine Decapod Crustaceans of Florida. Florida Department of Environmental Regulation, Technical Series Vol. 8, No. 1.

Ache, B.W., Boyle, J.D., and Morse, C.E. 2000. *A Survey of the Occurrence of Mercury in the Fishery Resources of the Gulf of Mexico*. Prepared by Battelle for the U.S. EPA Gulf of Mexico Program, Stennis Space Center, MS. January 2000.

American Fisheries Society. 1985. Aquatic habitat inventory, glossary of stream habitat terms. W. T. Helm (ed.). Habitat Inventory Committee, Western Division, American Fisheries Society, Logan, Utah. 33 pp.

Anchor QEA. 2012. Draft Dredged Material Management Plan. Port of Pascagoula. Bayou Casotte and Lower Sound Channel Widening Project. Prepared for Jackson County Port Authority. January 2012.

Anderson, Donald M. 2007. Supported by NOAA/CSCOR/COP. *The Harmful Algae Page*. http://www.whoi.edu/redtide, http://www.whoi.edu/redtide/species/speciestable.html, and http://www.whoi.edu/redtide/whathabs/whathabs.html

Bailey, Robert G. Description of the ecoregions of the United States (2nd ed.). 1995. Misc. Pub. No. 1391, Map scale 1:7,500,000. USDA Forest Service.

Bates, R. L. and J. A. Jackson. 1980. Glossary of Geology, 2nd Edition. American Geological Institute.

Bates, R. L. and J. A. Jackson. 1984. Dictionary of geological terms. Anchor Press / Doubleday, New York.

Bedinger, M. S. 1979. Wetland function and values: The state of our understanding. American Water Resources Association, Minneapolis, MN.

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:///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, 17-23 May, 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. 171–188.

Book. MMS, USDOI, Gulf of Mexico OCS Region, MMS 2004-027. June 2004, 249pp.

Boschung, H.T. and R.L. Mayden. 2004. Fishes of Alabama. Smithsonian Institution. Washington, D.C. 736 pages.

Bradley, K.P. 2011. Correspondence from Kenneth P. Bradley, Chief, Environmental and Resources Branch, USACE Mobile District to M.T. Holmes, State Historic Preservation Officer, Mississippi Department of Archives & History. Dated 18 April 2011.

Brandt, K., and K. C. Ewel. 1989. Ecology and management of cypress swamps: A review. Florida Cooperative Extension Service, Gainesville, FL.

Bray, Greg. 2007. Gulf States Marine Fisheries Commission. Personal communication January 11, 2007.

Burrage, David D., Cathy Z. Hollomon, Benedict C. Posadas. 1999. *Mississippi Coastal Recreational Boating Access: Assessment and Projected Needs*. Mississippi State University Coastal Research and Extension Center. December 1999.

Cake, E. 1983. Habitat Suitability Index Models: Gulf of Mexico American Oyster. USFWS FWS/OBS-82/10.57

Cake, Edwin W. 1983. Coastal Barrier Islands And Shellfish in Proceedings of the Northern Gulf of Mexico Estuaries and Barrier Islands Research Conference, 1983.

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

California State Lands Commission, 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

Canadian Council of the Environmental (CCME). 2001 Canadian sediment quality guidelines for the protection of aquatic life: Polychlorinated dioxins and furans (PCDD/Fs). In: Canadian environmental guidelines, 1999, Canadian Council of Ministers of the Environment, Winnipeg.

Caputo, M. V., and S. M. Oivanki, 1992, Barrier islands, Mississippi Gulf Coast: Classification of geomorphic features: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 41.

Cato, J. and C.M. Adams. 1999. Economic significance of the Gulf of Mexico related to population, income, employment, mineral, fisheries, and shipping. In: H. Kumpf, K.

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.

Chatry, M., R. J. Dugas, and K. A. Easley. 1983. Optimum salinity regime for oyster production on Louisiana's state seed grounds. Contributions in Marine Science 26: 81-94.

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.

Chevron. 2007. Crude Oil Transportation and Storage at Chevron Pascagoula Refinery. http://www.chevron.com/products/about/pascagoula/refiningprocess/crudetrans.shtml#Anchor-Crude-14242

Christmas, J.Y. 1973. Area Description. In: Christmas, J.Y. (ed). Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Phase IV, Biology. Gulf Coast Research Laboratory, Ocean Springs, MS.

Christmas, J.Y. and C.K. Eleuterius, 1973. In: Christmas, J.Y. (ed). Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Phase IV, Biology. Gulf Coast Research Laboratory, Ocean Springs, MS.

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.

Churchill, E.P., Jr., and S.I. Lewis. 1924. Food and feeding in freshwater mussels. Bull. U.S. Bur. Fish. 39: 439-471.

City of Biloxi. 2010a. http://www.biloxi.ms.us/firedepartment

City of Biloxi. 2010b. http://www.biloxi.ms.us/policedepartment

City of Mobile Fire and Rescue Department. 2010. http://cityofmobile.org/fire/locations.php

City of Mobile Fire and Rescue Department. 2010.http://cityofmobile.org/fire/locations.phpCity of Mobile Police Department. 2010. http://www.cityofmobile.org/mobilepd/html/dept_info/PrecLocations/PrecLocation.html

City of Pascagoula. 2010a. City of Pascagoula Zoning Map. http://www.cityofpascagoula.com/zoning.pdf

City of Pascagoula. 2010b. http://www.cityofpascagoula.com/fire.htm

City of Pascagoula. 2010c. http://www.cityofpascagoula.com/police.htm

City-data.com. 2006. www.city-data.com

City-data.com. 2010. http://www.city-data.com

Clarke, D., C. Dickerson, and K. Reine. 2002. Characterization of Underwater Sounds Produced by Dredges. In *Proceedings of the Third Specialty Conference on Dredging and Dredged Material Disposal*. May 5–8 2002, Orlando, FL.

Clarke, D. G. and Wilber, D. H. (2000) "Assessment of Potential Impacts of Dredging Operations Due to Sediment Resuspension." ERDC TN- DOER- E9. May 2000

Clewell, A. F., and R. Lea. 1990. Creation and restoration of forested wetland vegetation in the southeastern United States. Pages 195-232 *in* J. A. Kusler and M. E. Kentula, eds. Wetland creation and restoration: The status of the science. Island Press, Washington D.C.

Code of Ordinances. 2006. Code of Ordinances, City of Pascagoula, Mississippi, Appendix B Zoning, Ordinance No. 13-2006, Supplement No. 6, Article X, Section 1008, Noise, dust and debris. http://library2.municode.com/mcc/DocView/13837/1/165/175?hilite=noise;noises

Collard, S. B. and C.N. D'Asaro. 1973. The biological movement – benthic invertebrates of the eastern Gulf of Mexico. p. III G-1 to III G-28. In. J.I. Jones, R.E. Ring, M. O. Rinkel and R. E. Smith (ed.) A summary of knowledge of the eastern Gulf of Mexico. State Univ. Sys. Florida, Inst. Oceanography, St. Petersburg, Florida

Colton Company. 2007. Colton Company Directory of US Shipyards. http://www.coltoncompany.com/shipbldg/directory1.htm

Compton, R., L. Goodwin, R. Handy, and V. Abbott. 2008. A Critical Examination of Worldwide Guidelines for Minimizing the Disturbance to Marine Mammals During Seismic Surveys. *Marine Policy* 32:255–262.

Couvillion, W.C. and A.J. Allen. 2001. Mississippi's Industrial Gulf Ports, Final Report, submitted to the National Center for Intermodal Transportation. Department of Agricultural Economics, Mississippi State University, Mississippi State, MS. September 2001.

Cowardin, L. M., V. Carter, F. C. Golet and E. T. LaRoe. 1979. Classification of wetlands and deepwater habitats of the United States. Office of Biological Sciences, USFWS, U. S. Dept. of the Interior, Washington, DC. FWS/OBS-79/31.

Crowder, L. and S. Heppell. 2011. The decline and rise of a sea turtle: How Kemp's ridleys are recovering in the Gulf of Mexico. Solutions 2: 67-73.

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 35:131-139.

Dame, R. F. 1996. Ecology of Marine Bivalves. An Ecosystem Approach. CRC Press. New York. Pp. 254.

Demoran, W.J. 1979. A survey and assessment of reef shell resources in Mississippi Sound. University of Mississippi, Mississippi Mineral Resources Institute. Report of Investigations No. 794, 19 p.

Dickson, R. E., and T. C. Broyer. 1972. Effects of aeration, water supply, and nitrogen source on growth and development of tupelo gum and bald cypress. Ecology 53:616-634.

Dortch, M.S., M. Zakikhani, M. Noel, and S.-C. Kim. 2007. Application of a Water Quality Model to Mississippi Sound to Evaluate Impacts of Freshwater Diversions. Technical Report TR-07-XX. ERDC, Vicksburg, MS

Durako, M. J. 1994. Seagrass die-off in Florida Bay (USA): changes in shoot demography and populations dynamics. Mar. Ecol. Prog. Ser. 110:59-66.

Durako, M.J. 1995. Indicators of seagrass ecological condition: An assessment based on spatial and temporal changes associated with the mass mortality of the tropical seagrass *Thalassia testudinum*. Pp. 261-266 In: K.R. Dyer and C. F. D'Elia (eds.) Changes in fluxes in estuaries: implications for science to management. Olsen and Olsen, Fredensborg, Denmark.

Ehrhart, L.M., D.A. Bagley, and W.E. Redfoot. 2003. Loggerhead turtles in the Atlantic Ocean Geographic distribution, abundance, and population status. Pgs 157-174 *in*: A.B. Bolten and B.E. Witherington. Loggerhead sea turtles. Washington D.C.: Smithsonian Institution Press.

Eleuterius, Lionel N. and S. B. Jones, Jr. 1969. A floristic and ecological study of pitcher plants bogs in southern Mississippi. Rhodora 71: 29-34.

Eleuterius, Lionel N. 1973. The marshes of Mississippi. In: Christmas, J.Y. (ed.). Cooperative GMEI. Phase IV, Biology. Gulf Coast Research Lab. pp. 147-190.

Eleuterius, Lionel N. 1973a. The Distribution of Certain Submerged Plants in Mississippi Sound and Adjacent Waters. In. Cooperative Gulf of Mexico Estuarine Inventory and Study, Mississippi. Christmas, J.Y. editor. Gulf Coast Research Laboratory, Ocean Springs, Ms.

Eleuterius, Lionel N. 1976. The distribution of Juncus roemerianus in the salt marshes of North America. Chesapeake Science. 17(4): 289-292.

Eleuterius, Lionel N. 1976a. Vegetative morphology and anatomy of the salt marsh rush, *Juncus roemerianus*. Gulf Research Reports. 5(2): 1-10.

Eleuterius, C.K. 1976b. Mississippi Sound Salinity Distribution and Indicated Flow Patterns. Gulf Coast Research Laboratory. Sea Grant Publication MASG-76-023.

Eleuterius, C. 1976c. Mississippi Sound, Temporal and Spatial Distribution of Nutrients. Mississippi-Alabama Sea Grant Consortium, MASGP-76-024. 20 pp.

Eleuterius, Lionel N. 1981. The Marine Flora of Mississippi Sound: A Review. Symposiumon Mississippi Sound June 25-26, 1981.

Ernst, C. H., J. E. Lovich, and R. W. Barbour. 1994. Turtles of the United States and Canada. Smiths. Inst. Press, Washington DC. 578 pp.

ESRI. 2005. USGS, Geographic Names Information System, Schools.

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.

Ewel, K. C., and H. T. Odum. 1984. Cypress swamps. University Presses of Florida, Gainesville, Florida.

Federal Energy Regulatory Commission (FERC). 2006. Final Environmental Impact Statement forthe Gulf LNG Clean Energy Project. Washington, D.C. http://www.ferc.gov/industries/gas/enviro/eis/2006/11-24-06-eis.asp

Firedepartments.net. 2010. http://www.firedepartments.net/county.html

Florida Marine Research Institute (FMRI). 2001. Florida's Inshore and Nearshore Species: 2001 Status and Trends Report. St. Petersburg, Florida.

Gardner, Helen/Pascagoula Economic Advisory Development Council (PEADC). 2007.

Garrison, Ervan G., Charles F. Giammona, Frank J. Kelly, Anthony R. Tripp, and Gary A. Wolff. Historic Shipwrecks and Magnetic Anomalies of the Northern Gulf of Mexico: Reevaluation of Archaeological Resource Management Zone 1, Volume 1: Executive Summary. Prepared for Minerals Management Service, New Orleans, LA. September 1989.

George, S.G., Dickerson, D.D., and Reine, K.J. 1996. Rediscovery of the inflated heelsplitter mussel, *Potamilus inflatus*, from the Pearl River drainage. Journal of freshwater ecology. 11(2): 245-246.

Global Security. 2010. Naval Station Pascagoula. http://www.globalsecurity.org/military/facility/pascagoula.htm

Guillory, V. 2001a. Blue Crab Home Page. Available at: http://www.blue-crab.net.

Gulf Ecological Management Site. 2010. Ship Island. Mississippi Department of Marine Resources. http://www.dmr.state.ms.us/Coastal-Ecology/GEMS/Ship-Island.htm

Gulf of Mexico Fishery Management Council. 1998. Generic amendment for addressing essential fish habitat 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. 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. 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 of Mexico Foundation. 2003. http://gulfmex.org/crp2007.html

Gulf States Marine Fisheries Commission. 2005. Licenses & Fees for Alabama, Florida, Louisiana, Mississippi, and Texas in their Marine Waters for the Year 2004. NOAA.

Gulfport Fire Department. 2010. http://www.ci.gulfport.ms.us/fire/Default.htm

Gulfport Police Department. 2010. http://www.ci.gulfport.ms.us/police

Haig, S.M. 1992. Piping Plover. In *The Birds of North America, No. 2.,* ed. A. Poole, P. Stettenheim, and F. Gill. The Academy of Natural Sciences, Philadelphia, PA, and The American Ornithologists' Union, Washington, DC.

Haig, S.M., and J.H. Plissner. 1992. The 1991 International Piping Plover Census. USFWS, Twin Cities, MN.

Haig, S.M., and J.H. Plissner. 1993. Distribution and abundance of piping plovers: Results and implications of the 1991 International Census. *Condor* 95:145–156.

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.

Hanna, W. H., 1981. Potential site disturbance from harvesting timber in wetlands. Pages 92-96 *in* Jackson, B. D. and J. L. Chambers eds., timber harvesting wetlands. Proceedings of the 30th annual forestry symposium. Louisiana State University Press, Baton Rouge, Louisiana.

Harrison County Sheriff's Department. 2010. http://www.harrisoncountysheriff.com

Harrison County. 2010. http://co.harrison.ms.us/departments/fire/index.asp

Hartfield, Paul. 1988. Status Survey for the Alabama heelsplitter mussel. *Potamilus inflatus* (Lea 1831). A report to the USFWS. 27 pp. + Appendix.

Havis, R. N. (1988). "Sediment resuspension by selected dredges," Environmental Effects of Dredging Technical Note EEDP-09-2, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Heise, R.J., W.T. Slack, S.T. Ross, and M.A. Dugo. 2005. *Gulf Sturgeon Summer Habitat Use and Fall Migration in the Pascagoula River, Mississippi, USA*. Journal of Applied Ichthyology. Volume 21 Issue 6, 461-468.

Hereford, S. 2012. Personal communication. Biologist, Mississippi Sandhill Crane National Wildlife Refuge, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

Hildebrand, John. 2003. Sources of Anthropogenic Sound in the Marine Environment. http://www.mmc.gov/sound/internationalwrkshp/pdf/hildebrand.pdf

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.

Hoggard, W. 1991. First recorded turtle nesting on Mississippi's man-made beach. Marine Turtle Newsletter 52: 11-12.

Huff, J.A. 1975. *Life History of Gulf of Mexico Sturgeon, Acipenser oxyrhynchus desotoi, in Suwannee River, Florida*. Florida Department of Natural Resources, Marine Research Laboratory. Number 6, November 1975.

Huntington Ingalls. 2012. http://www.huntingtoningalls.com/

HurricaneCity.com. 2010. Pascagoula, Mississippi's History with Tropical Systems. http://www.hurricanecity.com/city/pascagoula.htm

Hutchins, P. S., and S. M. Oivanki. 1994. A comparison of shoreline measurement techniques: GPS survey, air photo interpretation, and total station survey: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48

Ingalls Shipbuilding. 2002. Fact Sheet/Rationale, NPDES Permit No. MS0003069, Pascagoula, MS, Jackson County. February 2002.

Institute for Marine Mammal Studies. 2010. http://www.dolphinsrus.com/dolphins.php.

Irion, Jack B. Underwater Archaeological Investigations Ship Island Pass, Gulfport Harbor, Mississippi. Prepared by GAI Consultants, Inc. for the U.S. Army Corps of Engineers, Mobile District. April 1989.

Jackson County Economic Development Foundation. 2010. http://www.jcedf.org

Jackson County Fire District. 2010. http://www.co.jackson.ms.us/ds/FireDistrict.html

Jackson County Port Authority. 2010. Port of Pascagoula. http://www.portofpascagoula.com

Jackson County. 2010a. http://www.co.jackson.ms.us/DS/SheriffContact.html

Jackson County. 2010b. Jackson County Port Authority, http://www.co.jackson.ms.us/BC/BCPortAuthority.html

Jarrell, J.D., M. Mayfield and E. N. Rappaport. 2001. NOAA Technical Memorandum NWS TPC-1: The Deadliest, Costliest, and Most Intense United States Hurricanes from 1900 to 2000. http://www.aoml.noaa.gov/hrd/Landsea/deadly/index.html

Jarrell, J.P. 1981. Hydrodynamics of Mobile Bay and Mississippi Sound Pass-Exchange Studies. Mississippi-Alabama Sea Grant Consortium MASGP-80-023.

Johnson, H.N., W. H. McAnally, and S. Ortega-Achury, 2010. Sedimentation Management Alternatives for the Port Of Pascagoula, Prepared for Mississippi Department of Transportation, 76 p.

Jordan, R.A. 1998. Species Profile: Pine Snakes (*Pituophis melanoleucus ssp.*) on Military Installations in the Southeastern United States. Technical Report SERDP-98-5. ERDC, Vicksburg, MS.

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.

Koplin, Steven. 2010. National Marine Fisheries Service–Fisheries Statistics Division. Personal communication. January 16, 2010.

LaSalle, M. W. (1990). "Physical and chemical alterations associated with dredging." *Proceedings, Workshop on the Effects of Dredging on Anadromous Pacific Coast Fishes,* Seattle, WA, September 8-9, 1988. C. A. Simenstad, ed., Washington Sea Grant Program, Seattle, WA, 1-12.

Lenihan, H. S. 1999. Physical-biological coupling on oyster reefs: how habitat structure influences individual performance. Ecological Monographs 69, 251-275.

Levinton, J.S. 1982. Marine ecology. Prentice-Hall, Englewood Cliffs.

Lighthousefriends.com. 2010a. "Ship Island, MS., 2001-2005," http://www.lighthousefriends.com/light.asp?ID=648

Lighthousefriends.com. 2010b. "Round Island, MS," http://www.lighthousefriends.com/light.asp?ID=339

Lincoln, R.J., G.A. Boxshall and P.F. Clark. 1982. A dictionary of ecology, evolution, and systematics. Cambridge University Press, Cambridge.

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.

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.

Little, R. J. and C. E. Jones. 1980. A dictionary of botany. Van Nostrand Reinhold Company, New York.

Lukens, J. 2000. National Coastal Program Dredging Policies: An Analysis of State, Territory, and Commonwealth Policies Related to Dredging and Dredged Material Management, Volume I of II. Office of Ocean and Coastal Resource Management Coastal Management Program Policy Series Technical Document 00-02, National Ocean Service, NOAA. April 2000.

Lusteck, Joseph A. & Associates, Inc. Real Estate and Planning Consultants. 2003. City of Gulfport Comprehensive Plan, http://www.ci.gulfport.ms.us/URBANDEV/DRAFT GulfportCompPlan.pdf

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.

MacDonald, D.D., R.S. Carr, F.D. Calder, E.R. Long, and C.G. Ingersoll. 1996 Development and Evaluation of Sediment Quality Guidelines for Florida Coastal Waters. *Ecotoxicology* 5:253-278

MacDonald, D.D. 1994. Approach to the Assessment of Sediment Quality in Florida Coastal Waters. Volume 1 – Development and Evaluation of the Sediment Quality Assessment Guidelines. Report prepared for Florida Department of Environmental Protection, Tallassee, Florida. Cited by MacDonald et al. 1996.

Mann, C. Baxter, Jr. 2000. A Phase I Cultural Resource Survey of the East Harrison County Connector, Harrison County, Mississippi. MDOT Project No. 94-1145-00-001-10/101212001000. Manuscript on file, Mississippi Department of Archives and History, Jackson, MS.

Mann, T., Mississippi Department of Wildlife, Fisheries and Parks. 2001, February 4. Letter to Claiborne Barnwell, MDOT. In Draft Environmental Impact Statement, East Harrison County Connector.

Mason, W.T., Jr., and J.P. Clugston. 1993. Foods of the Gulf sturgeon (*Acipenser oxyrinchus desotoi*) in the Suwanee River, Florida. *Transactions of the American Fisheries Society* 122:378–385.

McCoy, C.J. and R.C. Vogt. 1985. Graotemvs flavimaculata. Cat. Amer. Amphib. Rept. :403.1-403.2.

McGurk, M. D. 1986. Natural mortality of marine pelagic fish eggs and larvae: role of spatial patchiness. Marine Ecology Progress Series 34: 227-242.

Menzel, R.W. 1971. Checklist of the marine fauna and flora of the Apalachee Bay and the St. George Sound area (3rd edition). Dept. of Oceanography, Florida State University. Tallahassee, Florida. 126 pp.

Meyer, K. D., and M. W. Collopy. 1990. The status, distribution, and habitat requirements of the American swallow-tailed kite (*Elanoides forficatus*) in Florida. Final report, Florida Game and Freshwater Fish Commission, Nongame Wildlife Program; Tallahassee, Florida.

Meyer-Arendt, K. J. 1991. Human impacts on coastal and estuarine environments in Mississippi: GCS SEPM Foundation, Twelfth Annual Research Conference, Program and Abstracts, p. 141-148.

Meyer-Arendt, K. J. 1991a. Human response to coastal erosion: Modification of the Mississippi shoreline: Journal of the Mississippi Academy of Sciences, v. 36, no. 1, p. 41.

Meyer-Arendt, K. J. 1992. Human-environment relationships along the Mississippi coast: Mississippi Journal for the Social Studies, v. 3, no. 1, p. 1-10.

Meyer-Arendt, K. J. 1992a. Shoreline changes at Ocean Springs, Mississippi, 1900-1992: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 41.

Meyer-Arendt, K. J. 1993. Historical human impacts upon the Bellefontaine coast, Mississippi: Journal of the Mississippi Academy of Sciences, v. 38, no. 1, p. 40.

Meyer-Arendt, K. J. 1995. Beach and nearshore sediment budget of Harrison County, Mississippi: a historical analysis: MDEQ, Open-File Report 43, 65 p.

Meyer-Arendt, K. J., and S. M. Oivanki. 1994. Shorefront changes in Biloxi, Mississippi, 1853-1992: geologic and geographic foundations of "Casino Row": Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48.

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. 1349-30.

Minerals Management Service. 1999. Destin Dome Unit Development and Production Plan and Right-of-Way Pipeline Application. Draft Environmental Impact Statement. Volume 1. OCS EIS/EA MMS99-0040.

Minerals Management Service. 2000. *Cetaceans, Sea Turtles, and Seabirds in the Northern Gulf of Mexico: Distribution, Abundance and Habitat Associations*. http://www.gomr.mms.gov/homepg/whatsnew/techann/000002.html

Minerals Management Service. 2004a. Historic Shipwrecks in the Gulf of Mexico. http://www.gomr.mms.gob/

Minerals Management Service. 2004b. OCS-Related Infrastructure in the Gulf of Mexico Fact

Minerals Management Service. 2006. http://www.gomr.mms.gov/homepg/regulate/environ/techsumm/2002/2002-055.html

Minerals Management Service. 2010. http://www.gomr.mms.gov/ homepg/fastfacts/WaterDepth/WaterDepth.html

Mississippi-Alabama Sea Grant Consortium, and Mississippi Cooperative Extension Service.

Mississippi Coastal Program SMA Task Force. 1985. Special Management Area Plan for the Port of Pascagoula Jackson County, Mississippi.

Mississippi Department of Environmental Quality. 1994. Belle Fontaine, Jackson County, Mississippi: Human History, Geology, and Shoreline Erosion. MDEQ.

Mississippi Department of Environmental Quality. 2000. State of Mississippi Water Quality Assessment 2000 Section 305(b) Report. MDEQ, Office of Pollution Control, Surface Water Division, Water Quality Assessment Branch. Jackson, Mississippi.

Mississippi Department of Environmental Quality. 2004a. National Coastal Assessment Data for the Mississippi Sound 2000-2004.

Mississippi Department of Environmental Quality. 2004b. Water Pollution Control Permit, Permit No. MS0055379. May 7, 2004. http://opc.deq.state.ms.us/search_ai_alt.aspx.

Mississippi Department of Environmental Quality. 2005a. Water Pollution Control Permit, Permit No. MS0057151. November 7, 2005. http://opc.deq.state.ms.us/search_ai_alt.aspx

Mississippi Department of Environmental Quality. 2005b. 2005 Air Quality Data Summary. http://www.deq.state.ms.us/MDEQ.nsf/pdf/Air_2005AirQualityDataSummary/$File/2005%20Air%20Quality%20Data%20Summary.pdf?OpenElement

Mississippi Department of Environmental Quality. 2006a. State of Mississippi Water Quality Assessment 2006, 305b report.

Mississippi Department of Environmental Quality. 2006b. National Coastal Assessment Data for Mississippi Sound 2000-2004.

Mississippi Department of Environmental Quality. 2010a. Water Pollution Control Permit, Permit No. MS0060518. February 9, 2010. http://opc.deq.state.ms.us/search_ai_alt.aspx.

Mississippi Department of Environmental Quality. 2012. Wastewater Discharge Permits. http://yosemite.epa.gov/r10/water.nsf/NPDES+Permits/Permits+Homepage

Mississippi Department of Environmental Quality. 2007b. Water Pollution Control Permit, Permit No. MS00648445. July 23, 2007. http://opc.deq.state.ms.us/search_ai_alt.aspx. Accessed December 5, 2007.

Mississippi Department of Environmental Quality. 2007c. Water Pollution Control Permit, Permit No. MS0020249. March 23, 2007. http://opc.deq.state.ms.us/search_ai_alt.aspx.

Mississippi Department of Environmental Quality. 2007d. Mississippi Fish Tissue Advisories and Commercial Fishing Bans. http://deq.state.ms.us/Mdeq.nsf/page/FS_Fish_Tissue?OpenDocument.

Mississippi Department of Geology. 2007. http://geology.deq.state.ms.us/coastal/NOAA_DATA/Publications/Publications/Coastwide/Geology%20and%20Geomorphology%20of%20the%20Coastal%20Counties.pdf

Mississippi Department of Marine Resources. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume One: History, Art, and Culture of the Mississippi Gulf Coast. MDMR.

Mississippi Department of Marine Resources. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Two: Mississippi's Coastal Environment. MDMR.

Mississippi Department of Marine Resources. 1998. Marine Resources and History of Mississippi Gulf Coast, Volume Three: Mississippi's Marine Industry, Economics, and Law. MDMR.

Mississippi Department of Marine Resources. 2003. Press Release September 23, 2005.

Mississippi Department of Marine Resources. 2007a. Oystering. http://www.dmr.state.ms.us/Fisheries/oystering.htm

Mississippi Department of Marine Resources. 2007b. Shrimping. Website: http://www.dmr.state.ms.us/Fisheries/shrimping.htm

Mississippi Department of Marine Resources. 2007c. Crabbing. Website: http://www.dmr.state.ms.us/Fisheries/crabbing.htm

Mississippi Department of Marine Resources. 2007d. Seasons and Regulations. http://www.dmr.state.ms.us/Regulations/seasons.htm

Mississippi Department of Marine Resources. 2007e. Shrimp Fishery, Marketing.http://www.dmr.state.ms.us/Marketing/Seafood-Mkt/shrimp-fishery.htm

Mississippi Department of Transportation. 2004. Mississippi Unified Long Range Transportation Infrastructure Plan (MULTIPLAN) Phase 1 website: http://www.mdotmultiplan.com/.

Mississippi Department of Transportation. 2005. Estimated 2005 Annual Average Daily Traffic: Pascagoula, Map No. 44. http://www.gomdot.com/maps/coast_aadt/coast44.pdf

Mississippi Department of Wildlife, Fisheries and Parks. 2005. Mississippi's Comprehensive Wildlife Conservation Strategy 2005-2015. Mississippi Museum of Natural Science. Version 1.1.

Mississippi Governor's Office of Recovery and Renewal. 2007. Mississippi Recovery FactSheet,http://www.governorbarbour.com/recovery/documents/RecoveryFactSheet8-25-06.pdf

Mississippi Gulf Coast. 2007. http://www.gulfcoast.org/static/index.cfm?contentID=328

Mississippi Legislature Joint Committee on Performance Evaluation and ExpenditureReview. 2006. The Mississippi Legislature Report # 487: The Impact of Hurricane Katrina onMississippi's Commercial Public Ports and Opportunities for Expansion of the Ports.http://www.peer.state.ms.us/reports/rpt487.pdf

Mississippi Museum of Natural Science. 2007. Natural Heritage Inventory: HarrisonCounty. http://www.mdwfp.com/museum/html/research/query_animals.asp

Mississippi Phosphate Corporation. 2007. http://www.missphosphates.com

Mississippi Press. 2006. "Numbers tell a story about Hurricane Katrina," August 27, 2006,

Mississippi River/Gulf of Mexico Watershed Nutrient Task Force. 2001. 2001 Action Plan.

Mississippi State University. 2007. Coastal Research and Extension Center Marine Resources. http://www.msstate.edu/dept/crec/marine.html

Mississippi State University. 2012. Office of Mississippi State Climatologist. http://geosciences.msstate.edu/stateclimatologist.htm

Mistovich, T.S., C.E. Clinton, and B.J. Agranat. 1990. Literature, Archival, and Historic Review of Submerged Cultural Resources in the Lower Pascagoula and Escatawpa Rivers, Mississippi. Prepared for U.S. Army Corps of Engineers, Mobile District by Panamerican Consultants, Inc., Tuscaloosa, Alabama.

Mistovich, T.S., V.J. Knight, Jr., and C. Solis. 1983. Cultural Resources Reconnaissance of Pascagoula Harbor, Mississippi. Prepared for U.S. Army Corps of Engineers, Mobile District by OSM Archaeological Consultants, Inc., Moundville, Alabama.

Mitson, R. B. and Knudsen, H. P. 2003. Causes and effects of underwater noise on fishabundance estimation. Aquatic Living Resources 16: 255-263.http://www.edpsciences.org/articles/alr/pdf/2003/03/alr3043.pdf?access=ok

Mobile Area Chamber of Commerce. 2007. Phone Numbers. http://www.mobilechamber.com/phonenumbers.asp

Mobile County Commission. 2007. http://www.mobilecounty.org

Mobile County Sheriff's Office. 2007. http://www.mobileso.com

Mobile Police Department. 2005. Annual Report 2005.http://www.cityofmobile.org/mobilepd/AnnualReport.pdf

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. 87:161-171.

Moncrieff, C.A., T.A. Randall, and J.D. Caldwell. 1998. Mapping of Seagrass Resources in Mississippi Sound. The University of Southern Mississippi, Institute of Marine Sciences, Gulf Coast Research Laboratory. Ocean Springs, Mississippi.

Montague, C. L. and J. A. Ley. 1993. A possible effect of salinity fluctuation on abundance of benthic vegetation and associated fauna in northeastern Florida Bay. Estuaries 16:703-717.

Moody, J. and K. Schmid, 2003, Hurricane season 2002- Hancock County beaches [abs]:Mississippi Academy of Sciences, v. 48, 1, p. 45.

Moody, J. S., and S. M. Oivanki. 1992. Historical shoreline analysis of the Mississippi coastline: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 42.

Moore, Frank R.; Kerlinger, Paul, and Simons, Ted R. 1990. Stopover on a Gulf Coast barrierisland by spring trans-Gulf migrants. Wilson Bulletin. 102: 487-500. Migratory Bird Research Group, Department of Biological Science, University of Southern Mississippi. December1982. http://www.usm.edu/mbrg/Publications.html

Morton, R.A., 2007. Historical changes in the Mississippi-Alabama barrier islands and the roles of extreme storms, sea level, and human activities: U.S. Geological Survey Open-File Report 2007-1161, 38 p.

National Coastal Condition Report II. 2005. www.epa.gov/owow/oceans/nccr/2005/nccr2-factsheet.html

National Marine Fisheries Service. 1976. Fishery Conservation and Management Act of 1976.http://www.mms.gov/eppd/compliance/fcma/index.htm

National Marine Fisheries Service. 1996. Fishery Conservation and Management Act, Public Law 94-265, October 11, 1996, http://www.nmfs.noaa.gov/sfa/magact/mag1.html

National Marine Fisheries Service. 2003. Final Biological Opinion for Hopper Dredging Impacts on Sea Turtles. November 2003.

National Marine Fisheries Service. 2004. 2004 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. 2005. Final Biological Opinion for Hopper Dredging Impacts on Sea Turtles – Revision 1. June 2005.

National Marine Fisheries Service. 2007a. http://www.nmfs.noaa.gov/prot_res/species/ESA_species.html

National Marine Fisheries Service. 2007b. Final Biological Opinion for Hopper Dredging Impacts on Sea Turtles – Revision 2. January 2007.

National Marine Fisheries Service. 2007c. Annual Commercial Landing Statistics. http://www.st.nmfs.gov/st1/commercial/landings/gc_runc.html

National Marine Fisheries Service. 2007d. Total Commercial Fishery Landings at an Individual U. S. Port. http://www.st.nmfs.gov/st1/commercial/landings/lport_hist.html

National Marine Fisheries Service. 2007e. Total Commercial Fishery Landings for Mississippi by Month. http://www.st.nmfs.gov/pls/webpls/MF_MONTHLY_LANDINGS.RESULTS

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. 1998. *Marine Recreational Fisheries Statistics Survey. MRFSS Facts and Figures: Mississippi 1998.* <http://www.st.nmfs.gov>.

National Oceanic and Atmospheric Administration. 2001b. www.nmfs.noaa.gov/pr/acoustics/bibliography.htm

National Oceanic and Atmospheric Administration*. 2002.* Habitat Connections: Wetlands, Fisheries, & Economics in the Gulf of Mexico Coastal States. <*http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconnections/>.*

National Oceanic and Atmospheric Administration. 1999. Essential Fish Habitat: New Marine Fish Habitat Conservation Mandate for Federal Agencies. NOAA, HCD, Southeast Regional Office.

National Oceanic and Atmospheric Administration. 2000. *Fisheries Statistics and Economics*. <http://www.st.nmfs.gov/>.

National Oceanic and Atmospheric Administration. 2001a. *Threatened and Endangered Species.* <http://nmfs.noaa.gov/prot-res/species/turtles>.

National Oceanic and Atmospheric Administration. 2003. *U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments* – 2003.

National Oceanic and Atmospheric Administration. 2004a. 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. 2004b. www.noaa.gov

National Oceanic and Atmospheric Administration. 2006a. Sediment Quick Reference Tables, November, 2006 version.

National Oceanic and Atmospheric Administration. 2006b. National Ocean Service Coast Survey, Chart Number 11373. http://ocsdata.ncd.noaa.gov/OnLineViewer/GulfCoastViewerTable.htm

National Oceanic and Atmospheric Administration. 2007a. National Data Buoy Center: USM Station 42015. http://www.ndbc.noaa.gov/station_page.php?station=42015

National Oceanic and Atmospheric Administration. 2007b. Gulf of Mexico Essential Fish Habitat. http://ccma.nos.noaa.gov/products/biogeography/efh/gom-efh/index.shtml

National Oceanic and Atmospheric Administration. 2007c. National Marine Sanctuary Program. http://sanctuaries.noaa.gov/about/welcome.html

National Oceanic and Atmospheric Administration. 2007d. National Marine Sanctuaries. http://www.nos.noaa.gov/topics/oceans/nms/welcome.html

National Oceanic and Atmospheric Administration. 2007e. NMFS Mississippi Laboratories. http://www.mslabs.noaa.gov/

National Oceanic and Atmospheric Administration. 2007f. National Estuarine Research Reserve System, Grand Bay Reserve, Mississippi. http://nerrs.noaa.gov/GrandBay/

National Oceanic and Atmospheric Administration. 2012. Sea Turtle Strandings in the Gulf of Mexico. http://www.nmfs.noaa.gov/pr/species/turtles/gulfofmexico.htm.

National Park Service. 2007a. http://www.nps.gov/archive/guis/extended/MIS/MNature/Islands.htm

National Park Service. 2007b. Gulf National Seashore "Ship Island People." http://www.nps.gov/archive/guis/extended/MIS/MHistory/People.htm

National Park Service. 2007c. Gulf National Seashore "Centuries of Change." http://www.nps.gov/archive/guis/extended/MIS/MHistory/Time.htm

National Research Council. 2003. Committee on Potential Impacts of Ambient Noise in the Ocean on Marine Mammals. Ocean Noise and Marine Mammals. http://books.nap.edu//catalog/10564.html%20National%20Academies%20Press#description

National Research Council. 2005. Committee on Characterizing Biologically Significant Marine Mammal Behavior. Marine Mammal Populations and Ocean Noise: Determining When Noise Causes Biologically Significant Effects. http://www.nap.edu/catalog/11147.html#toc%20National%20Academies%20Press

Natureserve Explorer. 2002. *An Online Encyclopedia of Life.* <http://www.natureserve.org/explorer>.

NatureServe Explorer. 2007. Version 6.1.http://www.natureserve.org/explorer/servlet/NatureServe?init=Species

Natureserve. 2000. *An Online Encyclopedia of Life: Comprehensive Report: Red-Cockaded Woodpecker.* <http://www.natureserve.org/>.

Natureserve. 2001a. *An Online Encyclopedia of Life: Comprehensive Report: Black Pine Snake.* <http://www.natureserve.org/>.

Natureserve. 2001b. *An Online Encyclopedia of Life: Comprehensive Report: Eastern Indigo Snake.* <http://www.natureserve.org/>.

Natureserve. 2001c. *An Online Encyclopedia of Life: Comprehensive Report: Gopher Tortoise* <http://www.natureserve.org/>.

Natureserve. 2001d. *An Online Encyclopedia of Life: Comprehensive Report: Louisiana Quillwort.* <http://www.natureserve.org/>.

Natureserve. 2001e. *An Online Encyclopedia of Life: Comprehensive Report: Mississippi Sandhill Crane.* <http://www.natureserve.org/>.

Natureserve. 2001f. *An Online Encyclopedia of Life: Comprehensive Report: Pearl Darter* <http://www.natureserve.org/>.

Naval Station Pascagoula Official Website. 2007.http://www.cnsl.spear.navy.mil/nspascagoula/pages/contents.

NCCD. 2008. 2008. "Coastal Ecosystems Program - Gulf of Mexico" www.ncddc.noaa.gov

Nelson, J. 1989. Agriculture, wetlands, and endangered species: The Food Security Act of 1985. Endangered Species Technical Bulletin 14:1, 6-8.

Newcombe, C.P., and Jensen, J.O.T., 1996, "Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact," North American Journal of Fisheries Management, Vol. 16, pp. 693-727.

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 115-125.

Nicholls, J.L. 1989. Distribution and Other Ecological Aspects of Piping Plovers *(Charadrius melodus)* Wintering Along the Atlantic and Gulf Coasts. Master's thesis. Auburn University, Auburn, AL.

Nicholls, J.L., and G.A. Baldassarre. 1990. Habitat selection and interspecific associations of piping plovers along the Atlantic and Gulf Coasts of the United States. *Wilson Bulletin* 102:581–590.

Northrop Grumman Ship Systems. 2007. Ingalls Facility. http://www.ss.northropgrumman.com/company/ingalls.html

Noss, R. F., E. T. LaRoe III, and J. M. Scott. 1995. Endangered ecosystems of the United States: A preliminary assessment of loss and degradation. U.S. Department of the Interior, National Biological Service, Washington, D.C.

Odum, E. P. 1992. "Great Ideas in Ecology for the 1990s." *BioScience* 42, no. 7 (July 1992): 542–545.

Odum, E. P. 1996. *Ecology: A Bridge Between Science and Society*. Sunderland, MA: Sinauer Associates, 1996.

Odum, E. P. 1977. The Emergence of Ecology as a New Integrative Discipline. *Science* 195, no. 4284 (March 25, 1977).

Odum, E.P. 1971. *Fundamentals of Ecology*. 3rd ed. Philadelphia: W.B. Saunders Company, 1971.

Ogren, L. 1989. Distribution of juvenile and subadult Kemp's ridley turtles: Preliminary results from the 1984-1987 surveys. Proceedings of the first international symposium on Kemp's ridley sea turtle biology, conservation and management. J. Caillouet, C & J. Landry, A. College Station, TX, Texas A&M Sea Grant College Program:116-123pp.

Oivanki, S. M., and J. S. Moody. 1992. A profile analysis of the beach and nearshore, Hancock County, Mississippi: Journal of the Mississippi Academy of Sciences, v. 37, no. 1, p. 42.

Oivanki, S. M. 1993. Global Positioning System (GPS) in Mississippi, a status report: Journal of the Mississippi Academy of Sciences, v. 38, no. 1, p. 40.

Oivanki, S. M., B. Yassin, and J. S. Moody. 1993a. Man-made and natural changes on the Mississippi Gulf Coast: Gulf Coast Association of Geological Societies, Transactions, v. 43, p. 529.

Oivanki, S. M., J. S. Moody, and B. Yassin. 1993b. Historical shoreline analysis of the Mississippi Gulf Coast: Coastal Zone '93, Eighth Symposium on Coastal and Ocean Management, Proceedings, p. 3347-3354.

Oivanki, S. M., M. B. E. Bograd, and E. G. Otvos. 1993c. Bibliography of Mississippi Gulf Coast geology and related topics: MDEQ, Office of Geology, Circular 5, 34 p.

Oivanki, S. M., and B. E. Yassin. 1994. Geomorphic analysis and inventory of the Mississippi mainland coast: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 50.

Oivanki, S. M., and J. N. Suhayda. 1994a. Past and future erosion trends at Belle Fontaine, Jackson County, Mississippi: Journal of the Mississippi Academy of Sciences, v. 39, no. 1, p. 48.

Oivanki, S. M., ed. 1994b. Belle Fontaine, Jackson County, Mississippi: human history, geology, and shoreline erosion: Mississippi Office of Geology, Bulletin 130, 136 p.

Oivanki, S. M., K. J. Meyer-Arendt, and B. Yassin. 1995. Analysis of land use and land cover changes on the Mississippi coast: 1950s-1992: Gulf Coast Association of Geological Societies, Transactions, v. 45, p. 467-473.

Oivanki, S. M. 1996. Round Island, Jackson County, Mississippi: sand resources and restoration alternatives: Journal of the Mississippi Academy of Sciences, v. 41, no. 1, p. 55.

Oivanki, S. M. 1997. Belle Fontaine shoreline evolution model field test results: Journal of the Mississippi Academy of Sciences, v. 42, no. 1, p. 41.

Olesen B & Sand-Jensen K. 1994. Demography of shallow eelgrass (*Zostera marina*) populations - shoot dynamics and biomass development. J. Ecol. 82: 379-390

Olesen B & Sand-Jensen K. 1994a. Patch dynamics of eelgrass *Zostera marina*. Mar. Ecol. Prog. Ser. 106: 147-156

Olesen B & Sand-Jensen K. 1994b. Biomass-density patterns in the temperate seagrass *Zostera marina*. Mar. Ecol. Prog. Ser. 109: 283-291

Ortner, Peter B. and Michael J. Dagg. 2006*. Zooplankton Grazing And The Fate Of Phytoplankton In The Northern Gulf Of Mexico*; http://www.aoml.noaa.gov/general/project/ocdpbo5.html

Ortner, Peter B. and Michael J. Dagg. 2006a*. Zooplankton Grazing And The Fate Of Phytoplankton In The Northern Gulf Of Mexico*; http://www.aoml.noaa.gov/general/project/ocdpbo5.html

Otvos, E. G., Jr. 1981. "Barrier Island Formation Through Nearshore Aggravation – Stratigraphic and Field Evidence," Marine Geology*,* Vol 43, pp 195-243.

Otvos, E.G. 1985. Coastal Evolution, Louisiana to northwest Florida: Guidebook. American Association of Petroleum Geologists Meeting, New Orleans Geological Society. 91 p.

Otvos, E. G. 1988. Pliocene Age of Coastal Units, Northeastern Gulf of Mexico: 38th Annual meeting of the Gulf Coast Association of Geological Societies and American Association of Petroleum Geologists Regional Meeting, and the 35th Annual convention of the Gulf Coast Section of the Society of Economic Paleontologists and Mineralogists, p. 485-494.

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. 541-554.

Parauka, F.M., S.K. Alam, and D.A. Fox. 2001. Movement and habitat use of subadult Gulf sturgeon in Choctawhatchee Bay, Florida. Proceedings Annual Conference of the Southeastern Association of Fish and Wildlife Agencies 55: 280–297.

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.

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, Charles E., Stephen R. James, Jr., Michael C. Krivor, S. Dean El Darragai and Lori Cunningham. 2003. Refining and Revising the Gulf of Mexico Outer Continental Shelf Region High-Probability Model for Historic Shipwrecks. Final Report, Volume I: Executive Summary. Prepared for Minerals Management Service, New Orleans. December 2003.

Pearson, Charles and Mark Forsyth. 2006. “Develop Information Base and Management Protocols for the Coast Guard Debris Removal Mission off the Coast of Mississippi: Relative to Compliance with Section 106 of the National Historic Preservation Act.” April, 7, 2006.

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.

Pensacola Chamber of Commerce. 2007. http://www.pensacolachamber.com

Perret, W.S., J.E. Weaver, R.C. Williams, F.L. Johanson, T.D. McIlwain, R.C. Raulerson, andW.M. Tatum. 1980. Fishery profiles of red drum and spotted seatrout. Gulf States Mar.Fish. Comm., Ocean Springs, MS. No. 6.

Perry, Harriet M. 2007. Chapter 11, Book 2, *Marine Resources and History of the Gulf Coast.* Website: http://www.dmr.state.ms.us/Fisheries/shrimping.htm

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 Los Angeles. 2006. Berths 97-109 Container Terminal Project Draft EnvironmentalImpact Statement/Report (DEIS/DEIR), August 2006. http://www.portoflosangeles.org/environment_pn_deir_cs.htm

Port of Pascagoula. 2006. Fall 2006 E-News Report.http://www.portofpascagoula.com/frame4.htm

Port of Pascagoula. 2007. http://www.portofpascagoula.com/frame4.htm

Posadas, Benedict C. 2001. Comparative Economic Analysis of Using Constructed Wetlands in Recirculating Catfish Pond Production. Journal of Applied Aquaculture, 11(3): 1-20.

Puckett, C., and R. Franz. 2001. Gopher Tortoise: a Species in Decline. <http://edis.ifas.ufl.edu/Body_UW048>. Accessed August 27, 2001.

Putnam, J. A., G. M. Furnival, and J. S. McKnight. 1960. Management of southern hardwoods. Agriculture handbook 181. USDA, Forest Service. U.S. Government Printing Office, Washington, D.C.

RabbySmith, S.L. 2012. Archeological Phase II Testing of the Big Greenwood Island Site, 22JA516, Jackson County, Mississippi. Confidential Draft Report. Prepared for USACE Mobile District by Brockington and Associates, Inc., Pensacola, Florida.

Reynolds, C.R. 1993. Gulf Sturgeon sightings, historic and recent – a summary of public responses. U.S. Fish and Wildlife Service. Panama City, Florida. 40 pp.

Rheinhardt, R. D., Rheinhardt, M. C., and Brinson, M. M. 2002. A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing Wetland Functions of Wet Pine Flats on Mineral Soils in the Atlantic and Gulf Coastal Plains. ERDC/EL TR-02-9, U.S. Army ERDC, Vicksburg, MS.

Rhoads, D.C. and Germano, J.D. 1986. Interpreting long-term changes in benthic community structure: A new protocol. *Hydrobiologia* 142, 291- 308.

Rogillio, H.E. 1993. Status survey of Gulf Sturgeon in Louisiana. Louisiana Department of Wildlife and Fisheries. Project E1-1. 6 pp.

Rogillio, H.E. and R.T. Ruth. 2003. Gulf sturgeon winter habitat study along the Chandeleur Islands. Final Report for 2003. Project No.E701, Louisiana Department of Wildlife and Fisheries.

Ross, S.T. 1983. *A Review of Surf Zone Ichthyofaunas in the Gulf of Mexico*. Pp. 25-34 In Shabica,S.V., Cofer, N.B. and E.W. Cake (Eds.), Proceedings of the Northern Gulf of Mexico

Estuaries and Barrier Islands Research Conference. U.S. Department of the Interior NationalPark Service, Southeast Region Office, Atlanta, GA.

Ross, Stephen T. 2001. Inland Fishes of Mississippi. Mississippi Department of Wildlife, Fisheries, and Parks. University Press of Mississippi. 624 pages.

Rummel, R.G. 2002. Black bear activities in Mississippi. Black Bear Conservation Committee Newsletter 10(1). <http://bbcc.org/Newsletters/Volume10/Mississippi_Update.html>.

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.

Schmid, K. and E. Otvos. 2004. Geology and Geomorphology of the Coastal Counties in Mississippi-Alabama. http://geology.deq.state.ms.us/coastal/NOAA_DATA/Publications/Publications/Coastwide/Geology%20and%20Geomorphology%20of%20the%20Coastal%20Counties.pdf

Schmid, K., 1999, Geomorphic expression of erosion on the Mississippi Gulf Coast islands caused by Hurricane Georges: Journal of the Mississippi Academy of Science, Abstract with Programs, v. 44, 1.

Schmid, K., 2000a, Biennial Report of Sand Beaches; Hancock County, 1999: MDEQ, Office of Geology, Open File Report 110, 17 p.

Schmid, K., 2000b, Biennial Report of Sand Beaches; Harrison County, 1999: MDEQ, Office of Geology Open File Report 111, 16 p.

Schmid, K., 2000c, Effects of culverts on Mississippi's renourished beaches: Journal of the Mississippi Academy of Science, v. 45, 1, p. 42.

Schmid, K., 2000d, Historical evolution of Mississippi's barrier islands: Mississippi Environment, v. January/February, 2000.

Schmid, K., 2001a, Cat Island evolution, morphology, and hurricane response - 1995 to 2000: MDEQ, Office of Geology, Open File Report 132, 32 p.

Schmid, K., 2001b, Determining artificial vs. natural Holocene sedimentation, Hancock County, Mississippi: Mississippi Academy of Sciences, v. 46, 1, p. 40.

Schmid, K., 2001c, Using vibracore and profile data to quantify volumes of renourished sediments, Holocene thickness, and sedimentation patterns: Hancock County, Mississippi: MDEQ, Office of Geology, Open File Report 131, 33 p.

Schmid, K., 2001d, West Ship Island evolution, morphology, and hurricane response - 1995 to 2000: MDEQ, Office of Geology, Open File Report 133, 36 p.

Schmid, K., 2001e, Long-term nearshore sedimentation on a renourished beach: Hancock County, Mississippi: Geological Society of America Abstracts with Programs, Boston, MA, v. 33, 6, p. 340.

Schmid, K., 2002a, Bar morphology and relationship to shoreline change on a renourished beach: Harrison County, Mississippi: Mississippi Academy of Sciences, v. 47, 1, p. 40.

Schmid, K., 2002b, Biennial Report of Sand Beaches; Harrison County, 2001: MDEQ, Office of Geology, Open File Report, 111B, 33 p.

Schmid, K., 2002c, Biennial Report of Sand Beaches: Hancock County, 2001: MDEQ, Office of Geology, Open File Report 110B, p.

Schmid, K., 2003a, East Ship Island evolution, morphology, and hurricane response - 1994 to 2000: MDEQ, Office of Geology, Open File Report 134, 49 p.

Schmid, K., 2003b, Nearshore bar morphology with relationship to shoreline change on a renourished beach: Harrison County, MS: Proc. Coastal Sediments '03, May 18-23, Clearwater Beach, FL, CD-ROM

Schmid, K., and B. Yassin, 1999, Ship Island, Mississippi: an example of rapid hurricane-driven evolution: The Impact of Hurricane Camille: A Storm Impact Symposium to Mark the 30th Anniversary, New Orleans, LA.

Schmid, K., and B. Yassin, 2004, Mississippi coastal data node and value added GIS data products [abs]: Mississippi Academy of Sciences, v. 49, 1, p. 59.

Schmid, K., and E.O. Otvos, 2003, Deer Island, Coastal Mississippi - a geological and historical story: Mississippi Academy of Sciences, v. 48, 1, p. 45.

Schmid, K., B. Yassin, and J. Lana, 1999, Geo-Forensic applications for coastal resource inventory: Biloxi, Mississippi: Coastal Geo-Tools 99, Charleston, S.C.

Shafer, D. J., T. H. Roberts, M. S. Peterson, and K. Schmid. (in press). A Regional Guidebook for Applying the Hydrogeomorphic Approach to Assessing the Functions of Tidal Fringe Wetlands Along the Mississippi and Alabama Gulf Coast. U.S. Army ERDC, Vicksburg, Mississippi.

Shamban, A., 1982, Coastal processes and geomorphology, Barataria Pass, Louisiana: Baton Rouge, Louisiana State University unpublished M.S. theses, 121p.

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.

Southeast Regional Climate Center. 2007. Climate data for Pascagoula 3 NE, Mississippi (226718) Station. http://cirrus.dnr.state.sc.us/cgi-bin/sercc/cliMAIN.pl?ms6718

Stedman, S. and T. E. Dahl. July-August 2008. Coastal Wetlands and the Eastern United States: 1998-2004 Status and Trends. National Wetlands Newsletter, p. 18-20.

Stern, E.M. 1976. The freshwater mussels (*Unionidae*) of the Lake Maurepas-Pontchartrain- Borgne drainage system, Louisiana and Mississippi. Ph.D. Dissertation, Louisiana State University, Baton Rouge, LA. 206 pp.

Stout, J. P. 1984. The ecology of irregularly flooded salt marshes of the northeastern Gulf of Mexico: a community profile. Biol. Rep. 85(7.1). Washington, DC: U.S. Department of the Interior, USFWS.

Stout, J.B. and A.A. de la Cruz. 1981. Symposium on Mississippi Sound. Marshes of Mississippi Sound: State of the Knowledge.

Stout, J.B. and A.A. de la Cruz. 1981. Symposium on Mississippi Sound. Marshes of Mississippi Sound: State of the Knowledge. Sunherald. 2007. http://www.sunherald.com/mld/sunherald/living/special_packages/guide_to_gulf_coas t_living/15103322.htm

Stout. J.P. and M.G. LeLong. 1981. Wetland habitats of the Alabama coastal zone. Alabama Coastal Area Board, Mobile, Alabama. Technical Publication CAB81-01, MESC Contribution No. 040. 27 pp.

Texas Marine Mammal Stranding Network. 2007. http://www.sci.tamucc.edu/tmmsn/29Species/marine.html.

Thomsen, F. S. McCully, D. Wood, F. Pace, and P. White. 2009. *A generic investigation into noise profiles of marine dredging in relation to the acoustic sensitivity of the marine fauna in UK waters with particular emphasis on aggregate dredging. Marine Aggregate Levy Sustainability Fund (MALSF)*. MEPF Ref No. MEPF/08/P21.

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. Available on line at: http://www.gomr.mms.gov/PI/PDFImages/ESPIS/3/3196.pdf.

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. http://www.gomr.mms.gov/PI/PDFImages/ESPIS/3/3196.pdf.

Thornbury, W. D. 1969. Principles of geomorphology. John Wiley & Sons, Inc., New York. Corps, 2000. Dredged Material Management Plan for Maintenance of Bayou Casotte Inner Harbor, Pascagoula, Mississippi. Corps, Mobile District.

Turner, E. R. 2006. Will lowering estuarine salinity increase Gulf of Mexico landings? Estuaries and Coasts 29: 345-352.

Turner, J, L. Allen, A. Anton, M. Miller, R. Swann and J. Cebrian. 2005. SAVing the Gulf: Education, Restoration, Conservation. Mobile Bay National Estuary Program and Mississippi-Alabama Sea Grant Consortium (MASGP-04-047).

Turner, R.E. 2000. Wetland management IS fisheries management for Gulf of Mexico shrimp. Environmental Law Institute. National Wetlands Newsletter 22(6).

U.S. Army Corps of Engineers (USACE). 1935. The ports of Gulfport and Pascagoula, Miss.: Port Series No. 19, 105 p.

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 G.

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). 1985a. Feasibility Report Pascagoula Harbor, Mississippi Improvement of the Federal Deep-Draft Channel. Volume I: Main Report and Environmental Impact Statement. Mobile District.

U.S. Army Corps of Engineers (USACE). 1985b. Improvement of the Federal Deep-Draft Navigation Channel. Volume I: Main Report and Environmental Impact Statement.

U.S. Army Corps of Engineers (USACE). 1989. Gulfport Harbor, Mississippi. Final Environmental Impact Statement. Mobile District.

U.S. Army Corps of Engineers (USACE). 1990a. General Design Memorandum Pascagoula Harbor Channel Improvement – Appendix A Geotechnical Report.

U.S. Army Corps of Engineers (USACE). 1990b. Alternative Dredging Equipment and Operational Methods to Minimize Sea Turtle Mortalities. Waterways Experiment Station.EEDP-09-06. December 1990.

U.S. Army Corps of Engineers (USACE). 1993. Monitoring Cruise at the Western LongIsland Sound Disposal Site, July 1990. Prepared by SAIC.

U.S. Army Corps of Engineers (USACE). 1997. Limited Reevaluation Report, Pascagoula Harbor Channel Improvement, Phase II.

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). 2001. USACE, Mississippi Department of Environmental Quality, and the Mississippi Department of Marine Resources General Permit Program for the State of Mississippi. November 8, 2001.

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). 2004. Institute for Water Resources. Waterborne Commerce of the United States, Calendar Year 2004, Part 2 - Waterways and Harbors, Gulf Coast, Mississippi River System and Antilles.http://www.iwr.usace.army.mil/ndc/wcsc/pdf/wcusmvgc04.pdf

U.S. Army Corps of Engineers (USACE). 2005. Singing River Island, Mississippi Sound Gulf Sturgeon Critical Habitat Benthic Community Assessment, 2005. Prepared by Barry A. Vittor & Associates, Inc.

U.S. Army Corps of Engineers (USACE). 2006a. Mobile District. Correspondence. Comparison of Design Dimensions Table (11/30/06).

U.S. Army Corps of Engineers (USACE). 2006b. Final Post-Hurricane Katrina Evaluation of Dredged Material, Pascagoula River and Pascagoula Upper Sound Channels, Mississippi. Prepared by EA Engineering, Science, and Technology, INC. September 2006.

U.S. Army Corps of Engineers (USACE). 2007a. http://www.usace.army.mil/missions/water.html

U.S. Army Corps of Engineers (USACE). 2007b. Beneficial Uses of Dredged Material website:http://el.erdc.usace.army.mil/dots/budm/factsheets.cfm?Topic=Land%20Creation&Id=0),accessed January 2, 2007.

U.S. Army Corps of Engineers (USACE). 2007c. Tonnage for Selected U.S. Ports in 2004.http://www.iwr.usace.army.mil/ndc/wcsc/portton04.htm

U.S. Army Corps of Engineers (USACE). 2007d. Texas City Channel Deepening Project. Draft General Conformity Determination. Prepared by Berger/EA-JV.United States Coast Guard. 2006. U.S. Coast Guard. Integrated Deep Water System press release, 8/31/2006. http://www.uscg.mil/deepwater/media/pr_pcaf.htm, web siteaccessed January 10, 2007.

U.S. Army Corps of Engineers. 1994. USACE Environmental Laboratory, Coastal Ecology Branch. Reconnaissance Survey of the Offshore Dredged Material Disposal Sites, Gulfport Harbor, MS. Mobile, AL.

U.S. Census Bureau, Census 2000. http://factfinder.census.gov/servlet/DatasetMainPageServlet?_ds_name=DEC_2000_SF1_U&_program=DEC&_lang=en

U.S. Census Bureau. 2006a. Special Population Estimates for Impacted Counties in the GulfCoast Area, http://www.census.gov/Press-Release/www/emergencies/impacted_gulf_estimates.html

U.S. Census Bureau. 2006b. http://quickfacts.census.gov/qfd/index.html

U.S. Census Bureau. 2007. Poverty: Poverty Thresholds 2000. http://www.census.gov/hhes/www/poverty/threshld/thresh00.html

U.S. Bureau of Labor Statistics, Unemployment Rate in Harrison County, MS [MSHARR7URN], retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/MSHARR7URN, June 26, 2017

U.S. Coast Guard. 2006. U.S. Coast Guard. Integrated Deep Water System press release, 8/31/2006. http://www.uscg.mil/deepwater/media/pr_pcaf.htm

U.S. Department of Energy (DOE). 2012. Schedules of Key Environmental Impact Statements, 2005 through 2013. Office of NEPA Policy and Compliance, GC-54. Available at http://energy.gov/sites/prod/files/KeyEISSchedule_Feb2012.pdf

U.S. Environmental Protection Agency and US Army Corps of Engineers. 1991. Evaluation of dredged material proposed for ocean disposal. EPA503/8-91/001.

U.S. Environmental Protection Agency. 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. 1991. *Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site Located Offshore Pascagoula, Mississippi*. July 1991. Prepared by U.S. EPA, Region 4.

U.S. Environmental Protection Agency. 1999. Ecological condition of estuaries in the Gulf of Mexico. EPA 620-R-98-004. Office of Research and Development, National Health and Environmental Effects Research Laboratory, Gulf Ecology Division, Gulf Breeze, Florida. 80 pp.

U.S. Environmental Protection Agency. 2000. Estuarine and Coastal Marine Waters: Bioassessment and Biocriteria Technical Guidance. EPA-822-B-00-024.

U.S. Environmental Protection Agency. 2001. National Coastal Condition Report. National Coastal Condition Report (2001) Download Site. http://www.epa.gov/owow/oceans/nccr/downloads.html

U.S. Environmental Protection Agency. 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

U.S. Environmental Protection Agency. 2005. Water Quality Study of Bays in Coastal Mississippi Water Quality Report, October 28, 2005, Project #05-0926.http://www.epa.gov/region4/sesd/reports/2005-0926.html

U.S. Environmental Protection Agency. 2007. Toxic Release Inventory.http://oaspub.epa.gov/enviro/fii_master.fii_retrieve?postal_code=&city_name=pascagoula&county_name=&state_code=MS&all_programs=YES&program_search=1&report=1&page_no=1&output_sql_switch=TRUE&database_type=TRIS

U.S. Fish and Wildlife Service and National Oceanic and Atmospheric Administration. 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. USFWS and NOAA.

U.S. Fish and Wildlife Service. 1987. Habitat Management Guidelines for the Bald Eagle in the Southeast Region. USFWS, Southeast Regional Office.

U.S. Fish and Wildlife Service. 1989. Alabama Red-bellied turtle Recovery Plan. USFWS, Jackson, MS.

U.S. Fish and Wildlife Service. 1990. Endangered and threatened species recovery program: report to Congress. 406 pp.

U.S. Fish and Wildlife Service. 1991. Endangered and Threatened Wildlife and Plants; Threatened Status for the Gulf Sturgeon, Final Rule. Federal Register, Vol. 56, No. 189.

U.S. Fish and Wildlife Service. 1995. Gulf Sturgeon Recovery Plan. Atlanta, GA. 170 pp.

U.S. Fish and Wildlife Service. 2001. Endangered and Threatened Wildlife and Plants; Final Determinations of Critical Habitat for Wintering Piping Plovers; Final Rule.50 CFR Part 17. Federal Register / Vol. 66, No. 132 / Tuesday, July 10, 2001.

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. Federal Register,50 CFR Part 17, March 19, 2003, Volume 68, No. 53, http://frwebgate.access.gpo.gov/cgibin/getdoc.cgi?dbname=2003_register&docid=fr19mr03-15.pdf

U.S. Fish and Wildlife Service. 2007. Website: Threatened and Endangered Species System. http://ecos.fws.gov/tess_public/StateListingAndOccurrence.do?state=MS

U.S. Fish and Wildlife Service. 1990a. Gopher Tortoise Recovery Plan. USFWS, Jackson, MS.

U.S. Fish and Wildlife Service. 1990b. Recovery Plan for the Interior Population of the Least Tern *(Sterna antillarum).* USFWS, Twin Cities, MN.

U.S. Fish and Wildlife Service. 1993. Yellow-blotched Map Turtle *(Graptemys flavimaculata)* Recovery Plan. USFWS, Jackson, MS.

U.S. Fish and Wildlife Service. 1994. Draft Revised Recovery Plan for Piping Plovers Breeding in the Great Lakes and Northern Great Plains. USFWS, Twin Cities, MN.

U.S. Fish and Wildlife Service. 1995. Louisiana Black Bear Recovery Plan. USFWS, Jackson, MS.

U.S. Fish and Wildlife Service. 1996a. Recovery Plan for Louisiana quillwort *(Isoetes louisianensis Thieret).* USFWS, Atlanta, GA.

U.S. Fish and Wildlife Service. 1996b. Draft Environmental Assessment: Restoration of Avian Diversity on Monomoy, National Wildlife Refuge. USFWS, Chatham, MA.

U.S. Fish and Wildlife Service. 1998a, October 7. Letter to Mr. Henry Borovich, Post, Buckley, Schuh & Jernigan, Inc., from Larry E. Goldman, USFWS, Daphne, AL.

U.S. Fish and Wildlife Service. 1998b. *Sea Turtles.* <http://www.fws.gov>.

U.S. Fish and Wildlife Service. 2000. Endangered and Threatened Wildlife and Plants; Proposed Rule to List the Mississippi Gopher Frog Distinct Population Segment of Dusky Gopher Frog as Endangered. USFWS. Federal Register, 50 CFR Part 17., Vol. 65, No. 100.

U.S. Fish and Wildlife Service. 2001a. *ESA Basics:* Over 25 years of protecting endangered species. <http://endangered.fws.gov/pubs/esa%20basics.pdf>. Accessed April 13, 2001.

U.S. Fish and Wildlife Service. 2001b. Candidate and Listing Priority Assignment Form: *Pituophis melanoleucus lodingi.* <http://es.southeast.fws.gov/pdf/BPSform.PDF>. Accessed November 13, 2001.

U.S. Fish and Wildlife Service. 2001c. Species Account: Brown Pelican, from Endangered and Threatened Species of the Southeastern United States (The Red Book). <http://endangered.fws.gov/i/b/sab2s.html>. Accessed November 13, 2001.

U.S. Fish and Wildlife Service. 2001d. *Mississippi Sandhill Crane (Grus canadensis pulla)* Fact Sheet. <http://endangered.fws.gov/i/b/sab4n.html>. Accessed September 17, 2001.

U.S. Fish and Wildlife Service. 2001e. Candidate and Listing Priority Assignment Form: *Percina aurora.* <http://es.southeast.fws.gov/pdf/PD.PDF>. Accessed November 14, 2001.

U.S. Fish and Wildlife Service. 2001f. National Wetlands Inventory (NWI) GIS Data for Selected Quadrangles in Coastal Mississippi. USFWS, Arlington, VA.

U.S. Fish and Wildlife Service. 2001g. Threatened and Endangered Species in the Southeast Region. <http://endangered.fws.gov>.

U.S. Fish and Wildlife Service. 2001h. Endangered and Threatened Wildlife and Plants; Final Determination of Critical Habitat for Wintering Piping Plovers. USFWS. *Federal Register,* July 10, 2001, (Volume 66, Number 132), 50 CFR Part 17, RIN 1018-AG13, pp. 36037–36086.

U.S. Fish and Wildlife Service. 2003b. Endangered and Threatened Wildlife and Plants: Designation of Critical Habitat for the Gulf Sturgeon. *Federal Register*, March 19, 2003, 50 CFR Part 17, Vol. 68. No. 53.

U.S. Fish and Wildlife Service. 1982. Gulf Coast Ecological Inventory Map; Mobile-Ala., Miss., LA. area.

U.S. Fish and Wildlife Service. 1982. Gulf Coast Ecological Inventory Map; Mobile-Ala., Miss., LA. area

U.S. Fish and Wildlife Service. 1991. Endangered and Threatened Wildlife and Plants; Threatened Status for the Gulf Sturgeon, Final Rule. Federal Register, Vol. 56, No. 189.

U.S. Fish and Wildlife Service. 1992. Mississippi Sandhill Crane National Wildlife Refuge Checklist. Unpaginated. Jamestown, ND: Northern Prairie Wildlife Research Center Online. http://www/npwrc.usge.gov/resource/birds/chekbird/r4/sndhill.htm

U.S. Fish and Wildlife Service. 1993. Inflated Heelsplitter (*Lampsilis powelli*) Recovery Plan. USFWS Region 4, Atlanta, GA. 15 pp.

U.S. Fish and Wildlife Service. 1993. West Indian Manatee. Division of Endangered Species, Species Accounts. Endangered and Threatened Species of the Southeastern U.S. (The Red Book) FWS Region 4 -- As of 8/93.http://www.fws.gov/endangered/i/a/saa0c.html

U.S. Fish and Wildlife Service. 1993. West Indian Manatee. Division of Endangered Species, Species Accounts. Endangered and Threatened Species of the Southeastern U.S. (The Red Book) FWS Region 4 -- As of 8/93. http://www.fws.gov/endangered/i/a/saa0c.html

U.S. Fish and Wildlife Service. 1995. Gulf Sturgeon Recovery Plan. Atlanta, GA.170 pp.

U.S. Fish and Wildlife Service. 2001. Endangered and Threatened Wildlife and, Plants; Final Determinations of Critical Habitat for Wintering Piping Plovers; Final Rule.50 CFR Part 17. Federal Register / Vol. 66, No. 132 / Tuesday, July 10, 2001.

U.S. Fish and Wildlife Service. 2001i. Critical Habitat for Piping Plover *(Charadrius melodus)* <http://plover.fws.gov>. Accessed February 17, 2001.

U.S. Fish and Wildlife Service. 2003. Endangered and Threatened Wildlife and Plants; Designation of Critical Habitat for the Gulf Sturgeon; Final Rule. Federal Register, 50 CFR Part 17, March 19, 2003, Volume 68, No. 53, http://frwebgate.access.gpo.gov/cgibin/getdoc.cgi?dbname=2003_register&docid=fr19mr03-15.pdf

U.S. Fish and Wildlife Service. 2007. Website: Threatened and Endangered Species System. http://ecos.fws.gov/tess_public/StateListingAndOccurrence.do?state=MS

University of Delaware. 2006. Graduate College of Marine Studies & Sea Grant College Program. UD Marine Transportation Experts Analyze Hurricane Katrina's Effects on U.S. Shipping. http://www.ocean.udel.edu/newscenter/HurricaneKatrina.html

University of Rhode Island. 2003. Office of Marine Programs. Science of Sound in the Sea. http://www.dosits.org/science/ssea/2.htm

University of Southern Mississippi. 2007a. Migratory Bird Research Group. http://www.usm.edu/mbrg/BarrierIslands.html

University of Southern Mississippi. 2007b. Department of Criminal Justice, Mississippi Statistical Analysis Center. http://www.usm.edu/mssac/counties/george_county.htm

Vittor, B. A. 1981. Benthic Community Characterization of Mississippi Sound. Symposiumon Mississippi Sound. Sponsored by Mississippi Bureau of Marine Resources, USACE,

Vittor, B.A. and Associates. 1982. Benthic macroinfauna community characterizations in Mississippi Sound and adjacent waters. Final Report Contract No. DACW01-80-C-0427. Corps, Mobile District. 287 pp. plus appendices.

VT Halter Marine. 2007. Company Resources. http://www.vthm.com/

Wake, D.B. 1991. Declining amphibian populations. Science 253(5022):860.

Wake, D.B., and H.J. Morowitz. 1991. Declining amphibian populations--a global phenomenon? Findings and recommendations. Alytes 9(1):33-42.

Wilkinson, K. 2011, October 4. $1.4 billion Chevron facility now taking shape; first of what will be about 1,000 start work. The Mississippi Press. http://blog.gulflive.com/mississippi-pressnews/2011/10/14_billion_chevron_base_oil_fa.html

Williams, S.J., Penland, S., and Sallenger, A.H., Jr., eds., 1992, Louisiana Barrier island erosion study--atlas of barrier shoreline changes in Louisiana from 1853 to 1989: USGS Miscellaneous Investigations Series I-2150_A, 103 p.

Williamson, G. 2011a. Correspondence from Greg Williamson, Review and Compliance Officer, Mississippi Department of Archives to Kenneth P. Bradley, Chief, Environmental and Resources Branch, USACE Mobile District. May 10, 2011.

Williamson, G. 2011b. Correspondence from Greg Williamson, Review and Compliance Officer, Mississippi Department of Archives to Kenneth P. Bradley, Chief, Environmental and Resources Branch, USACE Mobile District. July 29, 2011.

Zieman, J.C., J.W. Fourqurean and T.A. Frankovich. 1999. Seagrass die-off in Florida Bay (U.S.A.): Long-term trends in abundance and growth of *Thalassia testudinum*. *Estuaries* 22:460-470.

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