Final
Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application

VOLUME I: MAIN TEXT

Docket No. USCG-2015-0472

November 2016

Prepared by:

FINAL ENVIRONMENTAL IMPACT STATEMENT

FOR

PORT DELFIN DEEPWATER PORT APPLICATION, Volumes 1 and 2

USCG DOCKET NUMBER: USCG-2015-0472

PREPARED BY: USCG Office of Operating & Environmental Standards (CG-OES) with technical support from Tetra Tech, Inc.

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Delfin LNG, LLC, a wholly owned subsidiary of Fairwood Peninsula Energy Corporation, seeks a Federal license under the Deepwater Port Act of 1974 (DWPA), as amended, to own, construct, operate, and eventually decommission a deepwater port for the liquefaction and export of liquefied natural gas (LNG). The proposed deepwater port would be located in Federal waters within the Outer Continental Shelf, West Cameron Area, West Addition Protraction Area (Gulf of Mexico) approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 feet (19.5 to 21.9 meters). Natural gas would be delivered to four moored floating LNG vessels (FLNGVs) through two existing offshore natural gas pipelines: the former U-T Offshore System (UTOS) and the High Island Offshore System (HIOS). A new 700-foot 42-inch diameter pipeline would be constructed to bypass an existing offshore platform at West Cameron lease block 167 (WC 167) and connect the UTOS and HIOS pipelines. Four new 30-inch diameter pipeline laterals, each approximately 6,400 feet in length, would connect the HIOS pipeline to each of the FLNGVs. Feed gas would be supplied through the new pipeline laterals to each of the FLNGVs where it would be super-cooled to produce LNG. The LNG would be stored onboard the FLNGVs and transferred via ship-to-ship transfer to properly certified LNG trading carriers. Each of the FLNGVs would be semi-permanently moored to four new weathervaning tower yoke mooring systems (TYMS). The Delfin onshore facility would consist of the return to FERC-jurisdictional service of approximately 1.1 miles of the existing UTOS pipeline; the addition of four onshore compressors totaling 120,000 horsepower of new compression; activation of associated metering and regulation facilities; and the installation of new supply header pipelines. The supply header would consist of 0.25 miles of new 42-inch diameter pipeline to connect the former UTOS line to the new meter station and 0.6 miles of new twin 30-inch pipelines between Transco Station 44 and the new compressor station site.

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Date	Reviewer	Title/Position

This document has been prepared in support of the Administrator of the Maritime Administration for purposes of issuing a Record of Decision for this deepwater port license application.

11/14/16	[signature]	Chief, Office of Operating and Environmental Standards
Date	Responsible Official	Title/Position

FINAL ENVIRONMENTAL IMPACT STATEMENT
FOR
PORT DELFIN LNG
DEEPWATER PORT LICENSE APPLICATION

Location: Federal waters within the Outer Continental Shelf, West Cameron Area, West Addition Protraction Area (Gulf of Mexico) approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana.

Docket Number: USCG-2015-0472

Prepared By: The U.S. Coast Guard (USCG) with technical support from its third party environmental contractor, Tetra Tech, Inc.

Cooperating Agencies: Federal Energy Regulatory Commission; U.S. Environmental Protection Agency; U.S. Department of the Interior's Bureau of Ocean Energy Management, Bureau of Safety and Environmental Enforcement, and U.S. Fish and Wildlife Service; U.S. Department of Commerce's National Oceanic and Atmospheric Administration, and National Marine Fisheries Service (NMFS); U.S. Army Corps of Engineers; U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration; and Department of Energy.

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Abstract: Delfin LNG, LLC, a wholly owned subsidiary of Fairwood Peninsula Energy Corporation, seeks a Federal license under the Deepwater Port Act of 1974 (DWPA), as amended, to own, construct, operate, and eventually decommission a deepwater port for the liquefaction and export of liquefied natural gas (LNG). The proposed deepwater port would be located in Federal waters within the Outer Continental Shelf, West Cameron Area, West Addition Protraction Area (Gulf of Mexico) approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 feet (19.5 to 21.9 meters). Natural gas would be delivered to four moored floating LNG vessels (FLNGVs) through two existing offshore natural gas pipelines: the former U-T Offshore System (UTOS) and the High Island Offshore System (HIOS). A new 700-foot 42-inch diameter pipeline would be constructed to bypass an existing offshore platform at West Cameron lease block 167 (WC 167) and connect the UTOS and HIOS pipelines. Four new 30-inch diameter pipeline laterals, each approximately 6,400 feet in length, would connect the HIOS pipeline to each of the FLNGVs. Feed gas would be supplied through the new pipeline laterals to each of the FLNGVs where it would be super-cooled to produce LNG. The LNG would be stored onboard the FLNGVs and transferred via ship-to-ship transfer to properly certified LNG trading carriers. Each of the FLNGVs would be semi-permanently moored to four new weathervaning tower yoke mooring systems (TYMS). The Delfin onshore facility would consist of the return to FERC-jurisdictional service of approximately 1.1 miles of the existing UTOS pipeline; the addition of four onshore compressors totaling 120,000 horsepower of new compression; activation of associated metering and regulation facilities; and the installation of new supply header pipelines. The supply header would consist of 0.25 miles of new 42-inch diameter pipeline to connect the former UTOS line to the new meter station and 0.6 miles of new twin 30-inch pipelines between Transco Station 44 and the new compressor station site.

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EXECUTIVE SUMMARY

Introduction

On May 8, 2015, Delfin LNG, LLC (hereinafter referred to as Delfin LNG or the Applicant), a wholly owned subsidiary of Fairwood Peninsula Energy Corporation (FPE), submitted an application to the U.S. Coast Guard (USCG) and Maritime Administration (MARAD) seeking a Federal license under the Deepwater Port Act of 1974 (DWPA), as amended, to own, construct, operate, and eventually decommission a deepwater port for the liquefaction and export of liquefied natural gas (LNG) in Federal waters approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana. The proposed deepwater port would be the first of its kind offshore terminal operated for the purpose of exporting LNG to the global market. Gas to be delivered to the floating LNG vessels (FLNGVs) would originate at the proposed Delfin Onshore Facility (DOF) in Cameron Parish, Louisiana. Natural gas would be delivered through two existing offshore natural gas pipelines of the former U-T Offshore System (UTOS)[1] and the High Island Offshore System (HIOS)[2] to be liquefied on four moored FLNGVs and transferred to LNG carriers (LNGCs) via ship-to-ship transfer. Concurrent with their application for the deepwater port, Delfin LNG submitted an application with the Federal Energy Regulatory Commission (FERC) requesting authorizations pursuant to Section 7(c) of the Natural Gas Act (NGA) and 18 Code of Federal Regulations (CFR) Part 157 to construct and operate the onshore facilities necessary for the proposed Project. Delfin LNG submitted a supplement to the application on June 19, 2015, at the request of the USCG and MARAD as a requirement for completeness and to demonstrate the suitability of the existing pipeline system for use, which was deemed complete on June 29, 2015. On September 17, 2015, Delfin LNG provided notice of its intent to submit a full amended application as a result of further technical design work and additional economic analysis increasing liquefaction capacity. Delfin LNG filed an amended application with the USCG, MARAD, and FERC on November 19, 2015. The proposed Port Delfin LNG Project (Delfin LNG Project or Project) was assigned a USCG Docket No. USCG-2015-0472 and a FERC Docket No. CP15-490-000, subsequently amended to CP15-490-001.

Together, the USCG and MARAD are the lead Federal agencies responsible for licensing of the proposed Port. FERC is the lead cooperating Federal agency responsible for review of the onshore natural gas pipeline and associated aboveground components. In accordance with Section 1504(f) of the DWPA and Section 7(c) of the NGA, this final Environmental Impact Statement (EIS) has been prepared in cooperation with additional Federal agencies and departments to comply with the requirements of the National Environmental Policy Act (NEPA) of 1969, and such compliance shall fulfill the NEPA responsibilities of such agencies and departments related to the licensing and review of the proposed Project and the requirements of NEPA, the DWPA and the NGA, USCG Commandant Instruction M16475.1D, the Department of Homeland Security Management Directive 23-01, Environmental Planning Program, the U.S. Department of Transportation (DOT) Order 5610.1C, “Procedures for Considering Environmental Impacts,” and Maritime Administrative Order 600-1, “Procedures for Considering Environmental Impacts.” The U.S. Department of Energy, U.S. Department of the Interior Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement, U.S. Fish and Wildlife Service, National Oceanic and Atmospheric Administration Fisheries Service, U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), and the U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration (PHMSA) are cooperating agencies for the purpose of this final EIS. They may incorporate the subsequent final EIS in their permitting processes.

[1] The UTOS naming convention is retained for ease of reference but technically describes the “former UTOS” pipeline system, which no longer exists as a legal entity and is now owned by Delfin Offshore Pipeline, LLC, a wholly owned subsidiary of Delfin LNG, LLC, “the Applicant.”

[2] The Applicant proposes to use a portion of the existing HIOS pipeline from West Cameron Block 167 to High Island Block (HI) A264 under a Pipeline Services Agreement with HIOS.

The DWPA establishes a licensing system for ownership, construction, and operation of deepwater ports in waters beyond the territorial limits of the United States. Originally, the DWPA promoted the construction and operation of deepwater ports as a safe and effective means of importing oil into the United States and transporting oil from the Outer Continental Shelf (OCS), while minimizing tanker traffic and associated risks close to shore. The Maritime Transportation Security Act of 2012 amended Section 3(9)(A)[3] to insert the words “or from” before the words “and State” in the definition of a deepwater port to grant the Maritime Administrator the authority to license the construction of deepwater ports for the export of oil and natural gas from domestic sources within the United States to foreign global markets.

Under the DWPA, all deepwater ports must be licensed by the Secretary of Transportation (Secretary). The Secretary has delegated authority to the USCG and MARAD to process applications submitted by private parties to construct, own and operate deepwater ports. The USCG retains this responsibility under the Department of Homeland Security. On June 18, 2003, the Secretary delegated authority to the Maritime Administrator to issue, transfer, amend, or reinstate a license for the construction and operation of a deepwater port. This delegation of authority is further specified in the August 17, 2012, amendment to 49 CFR part 1 Section 1.93 (h).[4] The responsibility for preparing the Record of Decision and for issuing or denying the Deepwater Port License has also been delegated to the Maritime Administrator. Hereafter, “the Secretary” refers to the Maritime Administrator as the delegated representative of the Secretary. On April 30, 2013, MARAD issued a Notice of Policy Clarification Concerning the Designation of Adjacent Coastal States for Deepwater Port License Applications advising the public that nautical miles shall be used when determining Adjacent Coastal State status. Pursuant to the criteria provided in the Act, Louisiana and Texas are the Adjacent Coastal States for the proposed Project. Other States may apply for Adjacent Coastal State status in accordance with 33 United States Code (U.S.C.) 1508(a)(1).

On July 16, 2015, MARAD issued a Notice of Application in the Federal Register,[5] summarizing the Applicant’s deepwater port application. Under procedures set forth in the DWPA, the USCG and MARAD have 240 days from the date of the Notice of Application to hold one or more public license hearings in the adjacent coastal State(s).

On September 18, 2015, the USCG and MARAD issued a letter to suspend the statutory timeline required by the DWPA, commencing on September 18, 2015 and ending on December 24, 2015 with the issuance of a Request for Comments.[6] This timeline suspension was issued to account for data gaps and the Applicant’s development of an amended DWPA license application. This period of suspension was not counted in determining the date prescribed by the time limits set forth in 33 U.S.C. 1504(g) and 1504(i)(4) of the DWPA.

On March 7, 2016, the USCG and MARAD issued a letter to suspend the statutory timeline required by the DWPA, commencing on March 7, 2016, and ending on July 8, 2016. This timeline suspension was issued to account for data gaps and the Applicant’s development of air quality and thermal plume modeling. This period of suspension was not counted in determining the date prescribed by the time limits set forth in 33 U.S.C. 1504(g) and 1504(i)(4) of the DWPA.

The Applicant also filed permit applications required under the Clean Water Act (CWA). The Applicant has prepared draft permit applications required under the Clean Air Act (CAA), but has not yet filed the permit application. An official permit application required under the CAA would be filed prior to

[3] 33 U.S.C. 1502(9)(A).
[4] Vol. 77, Federal Register, No. 160, Friday, August 17, 2012, p. 49985.
[5] Vol. 80, Federal Register, No. 136, Thursday, July 16, 2015, pp. 42162-65.
[6] Vol. 80, Federal Register, No. 247, Thursday, December 24, 2015, pp. 80455-56.

construction. If a DWPA license is issued, the Applicant would apply to BOEM for permits and approvals regarding the proposed Port facilities and a pipeline right-of-way.

Description of the Proposed Action

The proposed Project has both onshore and offshore components. The proposed deepwater port would be located in Federal waters of the Gulf of Mexico, approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 feet (ft). The proposed Port would reuse and repurpose two existing offshore natural gas pipelines: the former UTOS pipeline, and the HIOS pipeline, to transmit natural gas sourced from the onshore interstate pipeline grid to the offshore deepwater port.

Offshore Facilities: In addition to the existing UTOS and HIOS pipeline systems, the proposed Port facilities contained in the USCG and MARAD license application would consist of:

- four semi-permanently moored FLNGVs;
- four disconnectable tower yoke mooring systems (TYMS);
- four pipeline riser components;
- four service vessel mooring points;
- four 30-inch-diameter pipeline laterals, each approximately 6,400 ft in length; and
- one 700-ft, 42-inch-diameter bypass around existing West Cameron block 167 offshore manifold platform (WC 167) to connect the HIOS and UTOS pipelines.

Gas to be delivered to the FLNGVs would originate at the proposed DOF in Cameron Parish, Louisiana. Delfin LNG would use two existing and underutilized 42-inch outside-diameter pipelines, to be interconnected by a new bypass at WC 167 and new offshore laterals from the existing pipelines to the FLNGVs, which would be moored to a disconnectable TYMS. Each TYMS would consist of a pile jacket structure connected to a manifold deck module and turntable deck module, with an attached swivel stack. It is anticipated that each mooring structure would require the installation of four driven piles (approximately 78 inches in diameter by 300 ft in length; subject to change during detailed engineering design), one for each leg. Four new-build, custom-designed FLNGVs would be moored to each disconnectable TYMS, allowing these vessels to weathervane. The feed gas would be processed through a gas-metering skid and sent for pretreatment and liquefaction. Natural gas would be liquefied and stored on the FLNGVs until delivered to LNGCs via ship-to-ship transfer through offloading arms or cryogenic hoses, which would be able to accommodate all relative motions between the LNGC and FLNGV during cargo transfer. The four FLNGVs would be capable of producing a nominal capacity of 12.0 million metric tonnes per annum (MMtpa) of LNG, or 3.0 MMtpa each. Each FLNGV would include gas pretreatment and three liquefaction trains having a nominal capacity of 1.0 MMtpa each, providing the nominal capacity of 3.0 MMtpa. A single FLNGV would have an LNG storage capacity of approximately 210,000 cubic meters (m^3). The offloading system would be capable of accommodating LNGCs with nominal cargo capabilities ranging between 125,000 and 177,000 m^3. The FLNGVs would use air cooling to support the LNG liquefaction process, and would be capable of generating all required electrical power, and producing and storing on board demineralized water, freshwater, and potable water for process and other requirements.

Onshore Facilities: The onshore component of the proposed deepwater port, the DOF, would be located in Cameron Parish, Louisiana, and would be certificated by the FERC under a separate permitting process (see FERC Docket No. CP15-490-000). The proposed DOF would consist of:

- use of approximately 1.1 miles of existing UTOS pipeline;

- construction of new 120,000 horsepower (hp) compressor station, and associated metering and regulation facilities; and
- installation of new supply header pipelines inclusive of 0.25 mile of new 42-inch pipeline connecting the former UTOS pipeline to the new metering station and 0.6 mile of new twin 30-inch pipelines between Transcontinental Gas Pipe Line Company, LLC (Transco) Station 44 and the new compressor station site.

Delfin LNG would design the proposed DOF gas systems to have a maximum allowable operating pressure of 1,250 pounds per square inch gauge. A 120,000 ISO hp compressor station would be constructed to push the gas from the interconnection with existing gas infrastructure to the proposed Port. On September 12, 2015, Delfin LNG purchased from PSI Midstream Partners, L.P. (PSI) the property where the compressor station would be located. The following equipment would be required for the compressor station:

- four 30,000 hp Solar Titan 250 gas turbine-driven compressors,
- four gas coolers,
- three natural gas–fired, 600-kilowatt Waukesha VHP 3604 generators with Waukesha F3524GSI engines,
- two control buildings,
- office and warehouse buildings,
- pig[7] launcher, and
- check meter.

The check meter, contained within the compressor station site, would consist of multiple ultrasonic meters with switching valves as well as flow control valve(s) to control the quantity of gas transported to the FLNGVs. Over-pressure protection would be provided in the control system. The compressors, generators, and the two control buildings would be constructed on platforms elevated 25 ft above the ground surface in order to provide storm-surge protection. The compressors would be contained within two 80-ft by 100-ft compressor buildings (two compressors per building). The buildings would have an approximate total height of 70 ft above the ground surface. The three generators would be contained in a 40-ft by 80-ft building with a total height of 60 ft above the ground surface. The two control buildings would each be 15 ft by 55 ft with an approximate total height of 41 ft above the ground.

In addition to the buildings described above, Delfin LNG would purchase the Johnson Bayou Community Center to be re-purposed as project-related office space. Delfin LNG is currently negotiating with the Johnson Bayou Recreation District regarding the sale of the building and the construction of a new building at a different location in Johnson Bayou. Delfin LNG would also construct a new warehouse. The warehouse would be 50 ft by 100 ft with a total height of 35 ft above the ground.

The existing UTOS onshore pipeline is 42 inches in diameter and includes a mainline block valve and blowdowns south of Louisiana Highway 82. The UTOS onshore pipeline extends from the mean high water mark for approximately 1.1 miles to the Transco Station 44 property boundary. As part of the proposed Project, these facilities would be placed back into service and dedicated to the Delfin LNG Project. Delfin LNG would maintain a 50-ft-wide permanent easement during operation of the UTOS onshore pipeline.

The gas supply header would transport gas from the meter station site to the compressor station. The gas supply header would include approximately 0.25 mile of new 42-inch-diameter pipeline to connect the

[7] A pig is an internal tool that can be used to clean and dry a pipeline and/or to inspect it for damage or corrosion.

existing UTOS onshore pipeline with the meter station. Approximately 0.6 mile of two new 30-inch-diameter pipelines would extend from the meter station to the compressor station. The twin 30-inch-diameter pipelines would be maintained in a 70-ft-wide permanent right-of-way and buried to provide 36 inches of cover. An easement agreement with PSI has been reached for the supply header on PSI-owned property outside the limits of the compressor station.

Detailed descriptions of the Proposed Action are provided in Section 2.2.

Public Involvement

Agency and public participation in the NEPA process promotes open communication between the public and the government and enhances decision-making. All persons and organizations having a potential interest in the Secretary's decision whether to grant the license are encouraged to participate in the decision-making process.

The USCG and MARAD initiated the public scoping process on July 29, 2015, with the publication of a Notice of Intent (NOI) to prepare an EIS in the Federal Register.[8] The NOI included information on public meetings and informational open houses; requested public comments on the scope of the EIS; and provided information on how the public could submit comments by mail, hand delivery, facsimile, or electronic means. The closing date of August 28, 2015, was set for receipt of materials in response to the request for comments on the proposed Project. The NOI also announced the establishment of a public docket, accessible through the Federal Docket Management System (FDMS) website: http://www.regulations.gov under docket number USCG-2015-0472.

An Interested Party Letter, the NOI published in the Federal Register, and a fact sheet describing the proposed Project were sent to Federal, State, and local agency representatives; and other potentially interested parties (Appendix A). Public comments submitted as part of the scoping process were considered during the development of the draft EIS.

As an additional mechanism to facilitate public participation in the scoping process, the USCG and MARAD held an informational open house in Lake Charles, Louisiana, on August 18, 2015, and in Beaumont, Texas, on August 19, 2015. The open houses were attended by 27 recorded individuals (Louisiana: 14; Texas: 13). At the Lake Charles, Louisiana meeting, one individual provided oral comments and one individual provided oral comments at the Beaumont, Texas meeting. No written comments were submitted at either of the meeting locations.

In response to Delfin LNG's intention to amend its deepwater port application, the USCG and MARAD suspended the timeline for processing the application on September 18, 2015. On November 19, 2015, Delfin LNG submitted its amended application to the USCG and MARAD. Due to the significant and substantive changes between the original and amended applications, the USCG and MARAD determined it was necessary to provide Federal and State agencies another opportunity to review the Delfin LNG application. The 240-day statutory timeline for processing the Delfin LNG application was reset to zero. A Notice of Receipt of Amended Application was published in the Federal Register on December 24, 2015[9], re-initiating the public comment period. The closing date of January 19, 2016, was set for receipt of materials in response to the request for comments on the proposed Project. A total of 10 submissions from Federal and State agencies, 4 submissions from Native American Tribes, 1 submission from companies and organizations, and 1 submission from individuals were received on the FDMS Docket, as of May 20, 2016.

[8] Vol. 80, Federal Register, No. 145, Wednesday, July 29, 2015, pp. 45270-74.
[9] Vol. 80, Federal Register, No. 247, Thursday, December 24, 2015, pp. 80455-80456

FERC has established a publicly accessible docket, Docket No. CP15-490-000 (see 80 FR 30226, May 27, 2015) to receive and post matters related to the Delfin LNG project. The FERC initiated their public scoping process by issuing a *Notice of Scoping for the Proposed Delfin LNG Project and Request for Comments on Environmental Issues* for Docket No. CP15-490-000 on December 24, 2015.[10] In a related docket (CP16-20-000), FERC published a *Notice of Application* on December 7, 2015, regarding the abandonment of the HIOS system pursuant to Section 7(b) of the NGA and Part 157 of FERC's regulations.[11] As a cooperating agency, the FERC will play an important role in developing the environmental analysis for the FERC-jurisdictional facilities in the EIS. Thus, FERC staff will work with USCG and MARAD staff and contractors to ensure that the proposed DOF is thoroughly evaluated and that all scoping comments received are addressed, as appropriate, in the EIS. FERC staff will also evaluate reasonable alternatives to the proposed Project, and make recommendations on how to lessen or avoid impacts on various resource areas.

As of August 25, 2016, a total of 4 submissions from Federal and State agencies, 2 submissions from Native American Tribes, and 3 submissions from companies and organizations were received on the FERC docket. In addition, 15 requests for intervenor status, of which 9 also included protests, were filed on the two FERC dockets (CP15-490-000; CP16-20-000).

The USCG and MARAD issued a Notice of Availability (NOA) in the Federal Register on July 15, 2016, announcing the availability of the draft EIS for public review (Appendix B)[12]. The NOA included information on public meetings and informational open houses; requested public comments on the draft EIS; and provided information on how the public could submit comments by mail, hand delivery, facsimile, or electronic means. The comment period ended on August 29, 2016. Public comments submitted as part of the public comment process were considered during the development of this final EIS and are included with individual responses in Appendix C.

To facilitate public participation in the EIS process, the USCG, MARAD, and FERC held public meetings in Cameron, Louisiana, on August 9, 2016, and Beaumont, Texas, on August 10, 2016. Both public meetings were preceded by an informational open house. The public meetings were attended by 34 recorded individuals (Louisiana: 22; Texas: 12). Five people provided oral comments at each of the public meetings, all in support of the proposed Project. A total of 4 submissions from Federal agencies, 1 submission from a state agency, 2 submissions from non-governmental organizations, and 2 submissions from individuals were received on the FDMS Docket.

Alternatives Considered

NEPA requires that any Federal agency proposing a major action consider reasonable alternatives to the proposed action. Evaluation of alternatives assists in avoiding unnecessary impacts by analyzing reasonable options to achieve the underlying purpose that Delfin LNG may or may not have considered. Under the DWPA, MARAD has the decision-making authority to approve, approve with conditions, or deny a License Application for a deepwater port. Because MARAD is the decision-making authority, identifying its preferred alternative could be interpreted as inappropriate prior to the Secretary's assembling, reviewing, and analyzing all of the relevant information pertaining to the License Application, as required under the DWPA. As such, the Secretary will defer identification of the agency's preferred alternative until a decision is made to approve or deny a deepwater port License. If the License is approved, the Secretary will indicate the agency's preferred alternative in its Record of Decision issued under the DWPA.

[10] Vol. 80, Federal Register, No. 2, Tuesday, January 5, 2016, pp. 231-233
[11] Vol. 80, Federal Register, No. 234, Monday, December 7, 2015, pp. 76007-76009
[12] Vol. 81, Federal Register, No. 136, Friday, July 15, 2016, pp 46157-46159.

This analysis of alternatives broadens the scope of options that might be available to reduce or avoid impacts associated with the action as proposed by Delfin LNG. The NEPA environmental analysis is one of the nine factors the Secretary must consider in making a final determination (33 U.S.C. 1503c). Alternatives for a LNG deepwater port may extend to matters such as its specific design, location, methods of construction, and technologies for liquefying, storing and loading LNG.

This NEPA analysis evaluated the No Action Alternative, which refers to the continuation of existing conditions of the affected environment without implementation of the proposed Project. However, the proposed Project's objective to liquefy and export surplus domestic natural gas would not be satisfied under the No Action Alternative. Similarly, if the Secretary were to deny or postpone Delfin LNG's DWPA license application, the international demand for natural gas would not be met and would likely force international customers to seek other projects to satisfy the demand. Other license or certificate applications concerning proposals to export natural gas might be submitted to the Secretary or the Secretary of the FERC, or other means might be used to export natural gas, such as expansion or establishment of onshore LNG import terminals that would require construction of LNG export facilities, including storage tanks, liquefaction facilities, and compression facilities. Implementation of other such facilities would likely result in similar or greater impacts than the proposed Project. In addition, the No Action Alternative could require that potential end users make other arrangements to obtain natural gas or make use of available energy alternatives such as oil, coal, wind, solar, hydro, nuclear, or biomass, to compensate for the reduced availability of natural gas. It is purely speculative to predict the resulting measures that could be taken by the end users of the natural gas supplied by the proposed Project and the associated direct and indirect environmental impacts. However, each of these alternative approaches to meeting the energy needs of the target market would result in some level of environmental impacts. Although international energy conservation could also result from the No Action Alternative, that option is beyond the scope of this analysis.

Offshore, four different deepwater port designs were considered in the alternatives analysis for the proposed Project. All of the design concepts would require the construction of a pipeline to deliver the natural gas to the target market. Although each of these concepts has some adaptability of design, each also has some inherent features that are most compatible with certain environmental conditions and that lend themselves to specific business models. Because the FLNGV and fixed platform-based designs would meet the proposed Project purpose and need, is a proven technology, and meets environmental, engineering feasibility, and reliability criteria, these designs are considered to be a reasonable alternative and have been carried forward for detailed analysis in this final EIS.

Three LNG liquefaction technologies are available for the FLNGV design: expander process, single mixed refrigerant process, and dual mixed refrigerant process. The single mixed refrigerant technology was selected because it provides a balance between simplicity and efficiency for the nominal output of each FLNGV.

For LNG liquefaction facilities, two types of cooling media can be employed: open-loop, water-cooled heat exchangers or air-cooled heat exchangers. An open-loop, water-cooled system could use up to 201,905 gallons per minute or 807,620 gallons per minute for all four FLNGVs resulting in both impingement and entrainment mortality of aquatic organisms. The air-cooled system is less efficient, requires more space on the FLNGV, and is more expensive. However, the air-cooled system would result in negligible impacts on marine life. In addition, the air-cooled system would not require a cooling medium, such as glycol and freshwater mix, to be stored on board the FLNGV, which would preclude the consideration of freshwater cooling towers, thereby offsetting the additional space required on the FLNGV. The air-cooled system has been proposed as the cooling media due to the minimal environmental impacts associated with the air-cooled system compared to the water-cooled system and space requirements of the FLNGV.

In identifying a potential site for a LNG deepwater port terminal, the Applicant required that the proposed Port location be able to utilize existing pipeline infrastructure. The existing pipeline infrastructure had to be within 2 to 8 miles of a maritime shipping fairway and have the capacity to transport the required amount of natural gas to the proposed Port. Based on this analysis, only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems met the criteria for proximity to maritime shipping fairways. Therefore, only potential Port locations along these pipeline routes were evaluated and resulted in three potential alternative site locations. Neither alternative location would have significant impacts on resources in their respective vicinities or result in an environmental advantage over the other. However, Alternatives 2 and 3 would require further assessment of geophysical hazards; are 10 to 15 nautical miles farther from shore, respectively, which could require additional service trips as well as additional compression at the proposed DOF resulting in greater noise and air emissions; and are located in deeper waters, which could result in longer piles resulting in more noise impacts on marine species. The Secretary respects the Applicant's expertise to identify those LNG deepwater port locations that represent viable business opportunities and relies on applicants to present reasonable and objective consideration of alternative locations to support their license applications.

Reuse of WC 167 would result in the interaction with six other pipeline systems currently utilizing the platform, require the removal and replacement of UTOS facilities and potential increased compression as a result of loss of hydraulic efficiency. The Applicant proposes to bypass WC 167 and avoid any potential impacts described above. The bypass would impact approximately 700 ft of seafloor as a result of the new trench being dug for the bypass pipeline; however, these impacts would be considered negligible compared to the potential impacts from repurposing WC 167. No other bypass alternatives were considered or eliminated.

Installation of the TYMS mooring structure would require an anchoring mechanism to attach the structure to the seafloor. Five different anchor designs were considered in the alternatives analysis for the proposed Project. Limitations in substrate types for anchor deployment, location depth, potential area of benthic disturbance, as well as structural ability to physically hold the TYMS in place eliminated all but the use of driven piles.

Onshore, four potential DOF locations met the criteria for proximity to a gas supply pipeline for the proposed Port, to gas supply header pipelines, and to existing natural gas infrastructure, particularly for the HIOS/UTOS system. Alternatives #3 and #4 were the only greenfield locations proposed and development of a greenfield site would likely result in greater impacts to natural resources as compared with re-development and/or modifications to existing sites. Delfin LNG has determined that Alternative #1 would be their preferred location for the siting of the compressor station while Alternative #2 would be their preferred location for the siting of the meter station and interconnection with gas supply header pipelines.

The gas supply systems were dependent on the location of the proposed Port, pipeline, and DOF. Within the location of the proposed DOF, several existing pipelines have interconnections with Transco Station 44 where Delfin LNG's preferred location for the meter station would be located. Pipelines that currently interconnect with Transco Station 44 and therefore could supply gas to the proposed Project include ANR Pipeline Company, the Natural Gas Pipeline Company of America, Tennessee Gas Pipeline, and Transco. Because these pipelines exist within the proposed meter station location and could potentially supply gas to the proposed Project, an alternatives analysis was deemed not necessary because no new facilities would be constructed for the gas supply system.

The proposed Project is an export Project and, as such, any alternatives considered must be exportable. Therefore, energy alternatives such as nuclear and renewable resources are not considered reasonable alternatives and are not discussed. Likewise, energy conservation measures are not considered a reasonable alternative and are not discussed in this EIS.

Proposed Project Impacts

Delfin LNG has committed to implementing best management practices (BMPs) to the extent practicable to minimize environmental and social impacts due to the construction, operation, and decommissioning of the proposed Project (see Appendix G). BMPs are discussed by resource in Section 4 and are based on Federal and State guidance documents and regulations well as standard practices associated with the industry and the proposed Project area. Delfin LNG would develop and implement a Prevention, Monitoring, and Mitigation Program that would include monitoring to occur during construction and operation of the Port. The impact conclusions made in Section 4 take these BMPs into account with regard to mitigation and minimization of potential impacts.

Federal and State agencies may provide similar or additional measures as the environmental review for this proposed Project progresses. These measures will be addressed in the final EIS.

Water Resources

Offshore water resources (Sections 3.2 and 4.2) were evaluated for salinity, temperature, dissolved oxygen, turbidity, trace elements and physical oceanography were evaluated for this final EIS. Impacts on these resources from Project-related activities include hydrostatic testing, water intake and discharge, hazardous and non-hazardous deck drains, cooling water use, and accidental releases of fuel, oil, and other chemicals. Impacts on offshore water resources would be expected to occur in the area within and directly adjacent to the proposed Port location and proposed WC 167 bypass. Construction, operation, and decommissioning of the proposed Project would be highly localized to the surrounding waters and would be expected to result in minimal, impacts on physical oceanography and minor to moderate, sort-term and intermittent impacts on water resources in the Project area.

Wetlands and surface water resources (Sections 3.11 and 4.11) were evaluated for this final EIS. Impacts on these resources from Project-related activities include direct filing of wetlands and accidental spills and releases. Impacts on onshore water resources would be minor or negligible given the utilization of previously disturbed lands. Additionally, minor impacts on wetlands would be expected due to direct filling of palustrine scrub-shrub (PSS) and palustrine emergent (PEM) wetlands. Wetland losses would be permitted and mitigated under a USACE Section 404 Permit and Louisiana Department of Natural Resources Coastal Use Permit.

To minimize impacts on water resources, Delfin LNG would adhere to measures described in the Delfin LNG Procedures (Appendix F), Delfin LNG's *Wetland and Waterbody Construction and Mitigation Procedures* (Appendix F), and FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan* (FERC Plan; FERC 2013). Accidental releases of petroleum products or hydraulic fluids may occur and would result in an uncontrolled discharge to the environment; however, these characteristics are determined on a case-by-case basis and are regulated by the National Pollutant Discharge Elimination System Permit process regulated and administered by the USEPA. Therefore, Delfin LNG would implement spill control and mitigation measures identified in a Project-specific Spill Prevention, Control, and Containment (SPCC) Plan, Delfin LNG's Spill Prevention Response Plan for Construction (Appendix O), and Delfin LNG's Storm Water Pollution Prevention Plan for Large Construction Activities (Appendix O) to minimize potential impacts.

Biological Resources

Marine threatened and endangered species (Sections 3.3.5 and 4.3.1); marine mammals (Sections 3.3.7 and 4.3.3); coastal, marine, and migratory birds (Sections 3.3.8 and 4.3.4); marine vegetative communities (Sections 3.3.9 and 4.3.5), benthic communities (Sections 3.3.10 and 4.3.6); plankton (Sections 3.3.11 and 4.3.7); and managed and other fisheries (Sections 3.3.12 and 4.3.8) were evaluated for this final EIS. Impacts on these resources from Project-related activities include seabed disturbance and associated turbidity, intake and discharge, hydrostatic testing, accidental releases and spills, noise, vessel traffic, marine debris, lighting, and alteration to prey species. Normal activities associated with construction, operation and decommissioning would result in minor, adverse impacts, with the exception of vessel traffic and accidental releases of fuel, oil and other chemicals, which has the potential for moderate adverse impacts. Accidental releases of fuel, oil and other chemicals are unlikely to occur, but have the greatest potential to result in major adverse impacts on biological resources.

Impacts from construction, operation, and decommissioning of the proposed Project may affect, but are not likely to adversely affect, Endangered Species Act (ESA)-listed marine species. Most recent correspondence with the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) indicates that concurrence with the determination made in this final EIS that the proposed offshore activities are not likely to adversely affect Federally listed species is under review. The receipt of a NOAA Fisheries concurrence letter on the final EIS findings for Federally listed species will be included as a condition of the Record of Decision. Correspondence with NOAA Fisheries, with respect to the ESA, is presented in Appendix D, Agency Correspondence.

To minimize potential impacts on ESA-listed marine species, Delfin LNG would implement “soft-start” ramp-up procedures, use of bubble curtains, and Protected Species Observers would be present to conduct surveys before, during, and after all pile-driving activities to monitor for marine mammals within designated areas. All in-water construction activities would comply with Federal regulations to control the discharge of operational waste such as bilge and ballast waters, trash and debris, and sanitary and domestic waste that could be generated from all vessels associated with the proposed Project. The proposed Port would be designed and permitted under the DWPA, and thus be required to meet all lighting stipulations as noted in 33 CFR Part 149, including limiting the amount of light at the facility and downshielding lights whenever safety allows. Additionally, BMPs identified for water resources and noise would further minimize impacts on biological resources, including threatened and endangered species. Such measures would ultimately be tied to requirements outlined in a comprehensive mitigation monitoring plan.

Terrestrial threatened and endangered species (Sections 3.12.5 and 4.12.1); terrestrial mammals (Sections 3.12.6 and 4.12.2); avian resources (Sections 3.12.7 and 4.12.3); upland vegetation (Sections 3.12.8 and 4.12.4); and aquatic resources (Sections 3.12.9 and 4.12.5) were evaluated for this final EIS. Impacts on these resources from Project-related activities include ground disturbance, vegetation clearing, staging activities, wetland disturbance, stormwater runoff, fuel spills, and noise. Normal activities associated with construction, operation, and decommissioning of the proposed DOF are expected to be negligible. However, potential minor impacts could arise from the direct filling of 0.12 acre of wetlands.

Mitigation measures would be implemented to reduce impacts on the piping plover and its critical habitat to less than major levels. Given the proposed BMPs, construction, operation, and decommissioning of the proposed DOF may affect, but is not likely to adversely affect, the piping plover. The proposed Project would not degrade or destroy critical habitat for the piping plover. In a letter dated August 20, 2016, the U.S. Fish and Wildlife Service concurred with the determination that the proposed onshore activities are not likely to adversely affect Federally listed species and that no further ESA consultation would be necessary for this proposed Project. Correspondence with the USFWS, with respect to the ESA, is presented in Appendix D, Agency Correspondence.

To mitigate impacts on potential wildlife habitat within the proposed DOF, all areas not used for operations would be restored and revegetated following guidelines and BMPs in the Delfin LNG *Wetland and Waterbody Construction and Mitigation Procedures* (Appendix F) and FERC Plan (FERC 2013). Vegetation clearing and grading would occur during the non-breeding season (October through February) for most avian species so that impacts on breeding birds would generally be avoided. As noted previously, these mitigations would ultimately be tied to requirements outlined in a comprehensive mitigation monitoring plan.

Essential Fish Habitat

The context, intensity, and duration of potential direct and indirect impacts of the proposed Project on the relevant life history stages of EFH-designated species, their habitats, and their prey species that may occur in the Project area were evaluated for this final EIS (Sections 3.4 and 4.4). The ubiquitous presence of numerous overlapping categories of EFH for multiple species makes it infeasible to develop an effect determination for each unique combination of species/life stage/EFH. Short- to long-term localized impacts within the proposed Project area would occur as a result of construction, operation, and decommissioning of the proposed Project. The effects analysis supports the overall determination that no aspect of the proposed Project would result in substantial adverse effects on EFH; some beneficial impacts would result from placement of structures in the soft-bottom habitat at the proposed Project site. Overall, impacts on managed species with EFH in the proposed Project area would vary depending on the species, but no impact would be major.

The benthic and water column EFH that may be affected are ubiquitous in the northern Gulf of Mexico and would be expected to recover quickly from the minor disturbances associated with the proposed Project. BMPs related to water resources, biological resources, and noise would also further minimize potential impacts on EFH.

Geological Resources

Regional and local geology, topography, sediments, and mineral resources were evaluated for this EIS. Offshore geological resources (Sections 3.5 and 4.5) generally would not be affected by the proposed Project. Some minor short-term disturbance of seafloor sediments and bathymetry would be expected during construction and decommissioning, with minor long-term disturbance during operations. Delfin LNG would conduct geotechnical borehole sampling and testing prior to construction in order to verify the sediment conditions and ensure that no potential hazards would be located at an anchor location or would alter the performance of the TYMS system.

Minor adverse impacts on onshore geological resources (Sections 3.13 and 4.13) would be expected due to ground disturbance associated with construction of the proposed DOF. Such impacts would be localized and short-term, and are not expected to continue during operation and decommissioning. Construction, operation, and decommissioning of the proposed Project would not be expected to impact any mineral or paleontological resources to a major degree, or increase the risk associated with any geological hazards (landslides, seismicity, and liquefaction).

To minimize impacts on geological resources, Delfin LNG would follow BOEM guidelines for the proposed Project's installation and operation and would implement FERC guidelines as appropriate. Therefore, no additional mitigation activities are proposed.

Cultural Resources

The area of potential effect (APE) for archaeology includes all locations that would undergo disturbance due to construction, operation, and decommissioning of the proposed Project. Construction of the proposed Project has the potential to impact submerged cultural resources in the APE (Sections 3.6 and 4.6); however, studies completed within the proposed Port construction area and in offshore waters concluded that any potentially significant cultural resources in these areas may be avoided. Following construction, operation of the proposed Project would have no direct or indirect impacts on cultural resources since no new areas of seafloor would be impacted by operational activities. Decommissioning of the proposed Project would not be expected to result in impacts on submerged cultural resources provided that anchor handling plans and avoidance plans are implemented to avoid all identified targets and shipwrecks.

Phase I cultural resources survey and archaeological inventory were performed on two parcels deemed to have potential to contain archaeological resources not previously affected by the existing gas plant or Transco's Station 44 (Sections 3.14 and 4.14). Shovel testing and pedestrian survey resulted in the identification of a portion of a previously known archaeological site that was demonstrated to extend into the proposed DOF APE. Approximately 820 artifacts have been recovered from this site, which also has the potential to contain human remains. The site is currently recommended by Delfin LNG's contractor as potentially eligible for the National Register of Historic Places. Review of the known site information in relation to the proposed DOF footprint indicates that the site is located outside of the currently proposed construction footprint. Delfin LNG developed and would implement a site avoidance plan which would establish a "no work area." Delfin LNG's contractor requested, and received, the Louisiana State Historic Preservation Office's concurrence on the site avoidance plan that would be implemented during construction of the proposed DOF. There would be no direct or indirect impacts on cultural resources from the operation and decommissioning of the proposed DOF because no new areas of the APE would be impacted by operational activities.

Delfin LNG has developed *Unanticipated Discoveries Plans* for the offshore and onshore components proposed Project, which have been reviewed by the USCG, MARAD, and FERC (see Appendix J). All proposed Project construction, operation, and decommissioning personnel should be familiar with the plans and the steps Delfin LNG has agreed to follow in the event of the discovery of a significant cultural resource including human remains. Adherence to the *Unanticipated Discoveries Plans* and Delfin LNG's commitment to the Zone of Avoidance with respect to magnetic anomalies identified during surveys would reduce potential impacts.

Ocean Use, Land Use, Recreation, and Visual Resources

Ocean use, offshore recreation, and visual resources (Sections 3.7 and 4.7), as well as land use, onshore recreation, and visual resources (Sections 3.15 and 4.15) were evaluated for this final EIS. The area shorelines include a mix of residential development, open spaces, and industrial land used for manufacturing, marine, shipping, agricultural, and oil and gas development activities. Oil and gas activities and marine shipping industries dominate the current use and future development plans for ocean use in the proposed Project area.

Construction, operation, and decommissioning of the proposed Project would result in a combination of short- and long-term, minor and negligible, adverse impacts on ocean and land use, recreation, and visual resources. Construction of the proposed Project would result in short-term, adverse, minor impacts on ocean uses, recreation, and visual resources due to increased vessel traffic. Operation of the proposed Project would result in long-term, minor, adverse impacts due to enforcement of the Safety Zone, No Anchoring Areas (NAA), and Area to be Avoided (ATBA). However, oceangoing and commercial vessels, and oil- and gas-related activities, are common in offshore Louisiana and Texas and local mariners and residents in coastal communities are accustomed to their presence. Decommissioning of the proposed Project would result in similar impacts on ocean uses as those expected during construction; however, impacts would be of a lesser extent in both duration and extent.

Land use and visual resources onshore would also experience short-term, minor, adverse impacts due to presence of construction equipment and noise and land disturbance associated with construction activities. The Johnson Bayou Community Center is currently situated within the proposed DOF footprint and would become office space for Delfin LNG. To mitigate this impact, Delfin LNG would replace the community center per an agreement to be reached with Cameron Parish. Impacts on land use during operation of the proposed Project would be negligible because all other lands that would be used for operation of the proposed DOF are on properties used for natural gas facilities or existing and maintained rights-of-way.

Overall, impacts on ocean and land use, recreation, and visual resources due to construction, operation, and decommissioning of the Project would be minor and negligible; therefore, no additional mitigation activities are proposed.

Transportation

The Gulf of Mexico is heavily transited by cargo vessels, container ships, barges, and tankers carrying crude oil or other liquid commodities (Sections 3.8 and 4.8). The proposed Port would be located approximately 40 nautical miles from the coast of Cameron Parish, Louisiana, and be well beyond the regional vessel traffic control systems. The Gulf of Mexico, however, has a network of designated shipping safety fairways that are de facto marine highways for large commercial vessels, the closest being the Sabine Pass Safety Fairway, approximately 3.35 statute miles (5.39 kilometers) to the west. To avoid or minimize potential impacts, Delfin LNG's Deepwater Port Operations Manual (see Appendix K) would outline the procedures and mitigation measures, which would ultimately be tied to requirements outlined in a comprehensive mitigation monitoring plan, including the following:

- safety zones that are enforced around the construction site and the FLNGVs, once in service;
- a defined ATBA around each FLNGV;
- a defined NAA around each FLNGV;
- continued use of nearby safety fairways that encourage commercial traffic to transit away from the proposed Port;
- use of tugs to assist LNGCs to their berth alongside a FLNGV;
- requirements for a Mooring Master to join an LNGC 8 to 10 miles from the FLNGV to coordinate final transit to the proposed Port; and
- use of Broadcast Notice to Mariners and Security Calls to alert local traffic.

Recreational boating and fishing activities also take place in the proposed Project area where the majority of boat trips are taken for the purpose of recreational fishing. The distance from shore, however, serves to limit these activities.

Proposed Project activities would increase vessel traffic in the Sabine Pass Safety Fairway throughout the proposed Project lifespan. However, this increase would be minor in the context of existing vessel traffic; the number of large vessels associated with construction, as detailed in Section 4.3.1.1, represents a less than one percent increase in vessel traffic. Potential impacts resulting from increased vessel traffic are expected to be effectively avoided by maintaining safe navigation practices established through the 1972 Convention on the International Regulations for Preventing Collisions at Sea (72 COLREGS) along with enforcement of mitigating measures such as Safety Zones, NAAs, and ATBAs.

Air Quality

Regional climatology, existing ambient air quality, and climate change considerations associated with emissions of greenhouse gases were evaluated for this final EIS. A combination of short- and long-term predominantly minor adverse impacts on air quality would be expected during construction, operation, and decommissioning of the proposed Project.

Short-term, negligible, adverse impacts on air quality would result from the operation of construction vessels and ancillary equipment on the vessels during construction of the proposed Port facilities (Sections 3.9 and 4.9), and from non-road construction equipment, on-road vehicle exhaust, and fugitive dust emissions during construction of the proposed DOF (Sections 3.16 and 4.16). Delfin LNG would minimize emissions during construction, operation, and decommissioning through implementation of BMPs including recommended manufacturer operation and maintenance procedures, and use of best available control technology controls. Emitted air pollutants would include nitrogen oxides, volatile organic compounds, carbon monoxide, sulfur dioxide, particulate matter with an aerodynamic diameter less than or equal to 10 microns, particulate matter with an aerodynamic diameter less than or equal to 2.5 microns, and carbon dioxide equivalent emissions.

Air quality dispersion modeling has been conducted for the stationary and mobile source emissions associated with operation of the proposed Port (Section 4.9.2) based on a draft modeling protocol submitted to the USEPA. AERMOD was used to predict impacts within 10 kilometers of the proposed Project Safety Zone, including cumulative impacts from offshore platform emissions located within 20 kilometers of the proposed Port. This modeling determined that total impacts would be in compliance with all National Ambient Air Quality Standards (NAAQS) and Prevention of Significant Deterioration Class II increments.

Air quality dispersion modeling was also conducted for emissions associated with operation of the proposed DOF (Section 4.16.2). As requested by the FERC in support of their licensing process for the proposed DOF, this modeling has been updated to include cumulative impacts from specific nearby existing sources. This modeling determined that cumulative impacts from the proposed DOF and existing nearby sources would be in compliance with all NAAQS air quality standards with the exception of 1-hour nitrogen dioxide (NO_2). However, this modeled exceedance is primarily attributable to emissions from non-Project sources. The incremental contribution to 1-hour NO_2 from the proposed DOF was 4.06 micrograms per cubic meter ($\mu g/m^3$), which is approximately 2.2 percent of the NAAQS standard of 188 $\mu g/m^3$, and is less than the threshold quantity that USEPA considers to be a "significant" contribution to an exceedance of the NAAQS.

The scope of this EIS focuses on the direct and indirect impacts of the proposed LNG facility that is subject to MARAD's Federal action, the licensing of the construction and operation of the LNG facility, and the Federal actions of cooperating agencies, including but not limited to the FERC (certificating onshore components of the LNG facility) and USEPA (permitting under CWA and CAA). In response to the review of the draft EIS, a comment received from the USEPA (by letter dated August 29, 2016) recommended that the final EIS include an estimation of greenhouse gas (GHG) emissions associated with the production, transportation, and combustion of the natural gas proposed to be exported. While this EIS does include an estimation of GHG emissions related to construction, operation, and decommissioning activities, it does not include an analysis of upstream effects from potential induced production or downstream effects from the export of natural gas.

For this Project, Delfin LNG proposes to receive natural gas through its interconnection with other existing natural gas pipelines. The factors described under the Council on Environmental Quality's (CEQ) regulations for a meaningful analysis—including when, where, and how natural gas development would occur as related to the proposed project—are unknown.[13] Additionally, the FERC has determined that, while upstream development and production of natural gas might be a "reasonably foreseeable" effect of a proposed action, the actual scope and extent of potential GHG emissions from upstream natural gas

[13] The USEPA suggested that the final EIS consider DOE's *Addendum to Environmental Review Documents Concerning Exports of Natural Gas from the United States*, wherein the agency provides additional information to the public regarding the potential environmental impacts of unconventional natural gas production activities. The Addendum provides GHG emissions information from the upstream natural gas industry as a whole, but DOE recognized that lacking an understanding of where and when additional gas production will arise, the environmental impacts resulting from production activity induced by LNG exports to non-FTA countries are not "reasonably foreseeable" within the meaning of the CEQ NEPA regulations (40 CFR § 1508.7). See DOE (2014, p.2).

production is not reasonably foreseeable (see FERC 2015). CEQ's final guidance on evaluating GHG impacts does not require NEPA analyses to include such unforeseeable effects (CEQ 2016).

Regarding downstream GHG emissions from overseas transport, regasification, and combustion of exported LNG, Delfin LNG has an application pending before DOE to export LNG to non-free trade agreement nations. The necessary factors for a meaningful analysis, including the demand for LNG exported from this Project, the destination(s) of the exports, the transport routes, and the ultimate end uses of the LNG, are unknown and, as such, the GHG emissions from same are not reasonably foreseeable.[14]

Noise

Both airborne noise and underwater noise for onshore (Sections 3.10 and 4.10) and offshore facilities (Sections 3.17 and 4.17) were evaluated for this final EIS. A combination of short- and long-term minor impacts on air noise would be expected during construction, operation, and decommissioning of the proposed Project.

Minor impacts on the airborne or underwater noise environment would occur from vessel traffic, helicopter traffic, construction activities and operation of the onshore/offshore facilities. Short-term minor impacts would occur during the Port and pipeline installations. Offshore operations might produce a minor increase in underwater noise. Noise generated during proposed Port operations would not affect noise sensitive receptors onshore due to extended separation distances. Noise associated with decommissioning of the proposed Project could have short-term minor adverse impacts on local ambient airborne and underwater noise.

For the offshore noise environment, standard mitigation procedures for marine mammal monitoring and BMPs would be in place during construction, operation, and decommissioning, and would be tied to requirements outlined in the noise mitigation protocol and monitoring plan. Any anticipated underwater noise impacts with the potential to exceed Level A or Level B acoustic harassment thresholds will require the Applicant to obtain an Incidental Harassment Authorization from the National Oceanic and Atmospheric Administration National Marine Fisheries Service.

Onshore construction and operation of the proposed DOF would produce a minor increase of airborne noise; however, noise mitigation measures prescribed in the BMPs proposed by Delfin LNG would ensure noise criteria are met. Per FERC recommendation, post-construction noise surveys would be completed to document that the noise contribution attributable to full-load operation of the proposed DOF compressor station would be less than the FERC standard of 55 decibels on the A-weighted scale at nearby noise-sensitive areas. For the onshore noise environment, noise impacts from construction and operation would not require any additional mitigation measures beyond the BMPs proposed by Delfin LNG.

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[14] The USEPA suggested that the final EIS consider the analysis prepared by the DOE's National Energy Technology Laboratory (NETL) in 2014 into the estimated "life cycle" of GHG emissions for exporting LNG from the U.S. In the life-cycle analysis, NETL identified two representative markets for U.S. exported LNG—Rotterdam, Netherlands, and Osaka, Japan—then compared the total GHGs that would be emitted to generate one megawatt hour (MWh) of electricity in each market, using: (1) LNG imported from the United States; (2) LNG imported from closer regional sources; (3) natural gas exported via pipeline from Russia; and (4) regional coal. In each scenario, NETL considered carbon dioxide and methane emissions from all stages of fuel production, from extraction to final combustion. NETL concluded that exporting U.S. LNG to produce power in Europe and Asia will not increase GHG emissions compared to regional coal power, and that potential differences in GHG emissions relating to the use of U.S. LNG, regional LNG, or Russian gas are largely limited to "transport distance" and are otherwise "indeterminate" due to uncertainty in the modeling data. Additionally, NETL concluded that no significant increase or decrease in net climate impact is anticipated from any of these scenarios (see NETL 2014, § 7 Summary and Study Limitations, p. 18). Because NETL analyzed representative approaches for U.S. LNG exports, the general conclusions regarding GHG emissions from such exports are expected to apply to this Project.

Socioeconomics

Offshore socioeconomic conditions (Sections 3.18.5 and 4.18.4), including marine-based tourism and recreation, recreational and commercial fisheries, marine commerce and shipping, and OCS resources, and onshore socioeconomic conditions (Sections 3.18.6 and 4.18.1)), including population and demographics, housing, employment and income, land-based recreation and tourism, and public services were evaluated for this final EIS. Communities in the proposed Project area are closely tied to the oil and gas industry, both onshore and offshore.

Socioeconomic resources generally would not be adversely impacted by construction, operation, and decommissioning of the proposed Project. Construction, operation, and decommissioning would result in negligible impacts on population and demographics, housing, land-based recreation and tourism, and public services. Economic stimulus would result in beneficial impacts on employment and income in the region.

Due to the fact that the proposed Project leverages existing seabed assets to the degree that it does, the impacts on existing offshore industries and their associated economics would be minimal. The discrete areas that would require traditional construction activities are located within Delfin LNG lease areas and away from other active leases. Additionally, these construction activities would occur well outside of existing navigational channels and fairways such that mercantile shipping as well as petroleum vessels may proceed as usual. Impacts on recreational and commercial fishing would be minimal due to the fact that there is ample, comparable seabed on all sides of these small areas of construction. During operation, the total acreage that would be lost to commercial trawling within and between the ATBAs is approximately 10,784 acres.[15] Additionally, maritime recreation aside from fishing is negligible in the proposed Project area. Measures to address transportation concerns related to arrival and departure of the FLNGVs and other proposed Project vessels, such as Notices to Mariners, would minimize navigational risks to other vessels transiting the proposed Project area. No additional mitigation measures or monitoring is recommended, as overall impacts during construction, operation, and decommissioning of the proposed Project to socioeconomics would be minor or negligible.

Lastly, the addition of the proposed Project would serve to benefit the offshore petroleum industry as both a diverse addition to the existing offshore infrastructure portfolio and an intelligent repurposing of defunct facilities (a concept with few detractors). In addition, the proposed Project may benefit the many businesses that exist to service the offshore petroleum industry by increasing and diversifying their workload.

Safety

The proposed Project would increase vessel traffic in the vicinity of the Sabine Pass Safety Fairway and the Calcasieu Pass Safety Fairway; however, the location of the proposed Port, approximately 40 nautical miles off the coast of Cameron Parish, Louisiana, moves this traffic far from the more congested sections of these waterways. The offshore location of this proposed deepwater port provides a safety benefit of reducing the likelihood and consequences of collisions or allisions. The proposed Port location is also beyond the area of control of the USCG's Port Arthur Vessel Traffic Control System that was established to reduce risk of vessel collisions in the congested Sabine River.

While safety concerns might have minor, long-term, adverse or beneficial impacts on the decision-making processes of potential future proposals within the hazard area, there is no short-term or long-term, adverse, direct impact on activities outside the Safety Zone, NAAs, or ATBA (see Section 5.0).

[15] This number was generated based on an estimation of the entire area that would be lost to commercial trawling due to establishment of the ATBAs; however, it should be noted that this is larger than the individual ATBA acreages as it encompasses the area in between the four unique ATBAs.

Mitigation measures would be developed to effectively reduce anticipated hazards to the general public and vessels associated with the proposed Project. The Safety Zone would serve to exclude non-project vessels and the general public from the highest hazard zones surrounding the proposed Port. To further enhance navigation safety, the Applicant will request mitigation measures such as NAAs and ATBA per the deepwater port regulations and International Maritime Organization guidelines prior to commencement of construction. The NAA would serve to exclude all vessels from anchoring, thereby protecting Project components (i.e., proposed pipeline laterals) that do not lie within the Safety Zone. The NAAs would also serve to protect non-Project vessels from incidental damage from snagging gear on Port components.

This final EIS does not serve as the USCG's final safety screening for the proposed Project or the alternative Project locations. Should a license be issued, the Applicant would be required to submit a Final Port Operations Manual for review and approval by the USCG before LNG operations would commence. This manual would contain detailed plans and procedures to address routine operations and emergencies at the proposed Project location. The USCG's review would ensure that appropriate safety and security plans are included in the Operations Manual to minimize risk to proposed Project personnel, and the general public.

The DOT is mandated to prescribe minimum safety standards to protect against risks posed by pipeline facilities under Title 49, U.S.C. Chapter 601. The DOT's PHMSA administers the national regulatory program to ensure the safe transportation of natural gas and other hazardous materials by pipeline. It develops safety regulations and other approaches to risk management that ensure safety in the design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. Many of the regulations are written as performance standards that set the level of safety to be attained and allow the pipeline operator to use various technologies to achieve safety. PHMSA's safety mission is to ensure that people and the environment are protected from the risk of pipeline incidents. This work is shared with state agency partners and others at the Federal, State, and local level.

Cumulative Impacts

The potential impact of the proposed Project, when combined with the impacts from the other projects considered, would not result in a major cumulative contribution to impacts on resources within the cumulative impact areas (see Section 6.0). Although concurrent construction of the proposed Project and other projects in the vicinity of the proposed DOF would result in increased workers in the area, periods of increased traffic, and impacts on public services, additional mitigation would not be warranted. In addition, the incremental contribution of the proposed Port to the cumulative impacts on ship traffic navigation and safety would be minor compared to the existing levels of commercial, recreational, fishing, military, and oil and gas exploration and development traffic in the Gulf of Mexico. Therefore, with the implementation of Delfin LNG's BMPs, the impacts of the proposed Project when added with other projects' impacts would not result in major cumulative impacts.

Final Environmental Impact Statement for the Port Delfin LNG Project Deepwater Port Application

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Port Delfin Deepwater Port

Quick Reference

Item	Description of Proposed Facilities	Metric Units (if applicable)
Company and Ownership		
Applicant	Delfin LNG, LLC	NA
Applicant Address	Frederick Jones (CEO); Dan Werner (COO) 1100 Louisiana St., Suite #3550 Houston, TX 77002	NA
Proposed Deepwater Port Location		
Proposed Deepwater Port Location	Gulf of Mexico, approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana	69.3 to 75.6 kilometers
Proposed Outer Continental Shelf (OCS) Lease Block	West Cameron Block (WC) 314, 318, 319, 327, 328. 334, and 335	NA
Proposed Facility Coordinates (Floating Liquefied Natural Gas Vessel [FLNGV] Mooring Locations)	Mooring #1 29° 8' 13.1" N, 93° 32' 2.2" W Mooring #2 29° 6' 13.6" N, 93° 32' 42.4" W Mooring #3 29° 6' 40.7" N, 93° 30' 10.1" W Mooring #4 29° 4' 40.9" N, 93° 30' 51.8" W	NA
Water Depth at Facility Location	64–72 feet	20-22 meters
Production		
Annual Average Processed Feed Gas Per FLNGV (gas volume)	500 million standard cubic feet per day (MMscf/d)	14.1 million meters^3/day
Annual Average Processed Feed Gas Total (gas volume)	2 billion standard cubic feet per day (Bscf/d)	56.4 million meters^3/day
Annual Average Liquid Natural Gas (LNG) production (LNG volume) per FLNGV	149.5 Bscf/d	3.0 million metric tonnes per annum (MMtpa)
Annual Average Liquid Natural Gas (LNG) production (LNG volume) Total	598 Bscf/d	12 MMtpa
Annual Optimal Processed Feed Gas Per FLNGV (gas volume)	575 MMscf/d	16.3 million meters^3/day
Annual Optimal Processed Feed Gas Total (gas volume)	2.3 Bscf/d	65.2 million meters^3/day
Annual Optimal LNG Production (LNG volume) per FLNGV	164.4 Bscf/d	3.3 MMtpa
Annual Optimal LNG Production (LNG volume) Total	657.6 Bscf/d	13.2 MMtpa
Schedule and Service Life (If License Is Granted)		
Proposed Deepwater Port Service Life	30 years	NA
Start of Onshore Construction	Third Quarter 2018	NA
Start of Offshore Construction	First Quarter 2018	NA
Proposed Start of Commercial Operations	End of Summer 2019	NA
Full Operational	Summer 2022	NA

Item	Description of Proposed Facilities	Metric Units (if applicable)
New-Build FLNGV Specifications		
FLNGV Cargo Tank Capacity	7.5 million $feet^3$	211,460 $meters^3$
Average LNG Offtake per FLNGV	6.0 MMscf/d	170,000 $meters^3$/day
Number of LNG Offtakes per FLNGV per Year	40	NA
Total Offtake Flow Rate	317,832 scf/hour	9,000 $meters^3$/hour
FLNGV Design Draft	35.27 feet	10.75 meters
FLNGV Overall Length	1,167.3 feet	355.8 meters
Number of LNG Tanks	8 (2 rows of 4)	NA
Number of Liquefaction Trains	3	NA
Disconnectable Tower Yoke Mooring Systems (TYMS)		
Number of Disconnectable TYMS	4	NA
Water Depth at location	62–72 feet	18.9–21.9 meters
Number of Driven Piles per TYMS	4	NA
Driven Pile Diameter	78 inches	198.1 centimeters
Driven Pile Length	300 feet	91.4 meter
Port-Specific Marine Traffic		
Average Number of LNG Carrier (LNGC) Visits per Year	160	NA
Maximum Number of LNGC Visits per Year	160	NA
Average Number of Support Vessel Round Trips per Year	365	NA
Nearest Shipping Fairway to TYMS	3.1 nautical miles northeast of the Sabine Pass Safety Fairway	5.8 kilometers
Nearest Shipping Fairway with FLNGV connected to TYMS	2.9 nautical miles northeast of the Sabine Pass Safety Fairway	5.4 kilometers
Pipeline Risers (Deliver Natural Gas from Subsea Lateral Pipelines to FLNGVs)		
Number of Risers per TYMS	1	NA
Riser Diameter	30 inches	76.2 centimeters
Designed Gas Flow	500 MMscf/d	14.1 million $meters^3$/day
Pipeline Laterals		
Number of Pipeline Laterals	4	NA
Pipeline Diameter	30 inches	76.2 centimeters
Pipeline Length (per lateral)	6,400 feet	1,951 meters
Fixed Seafloor Depth	62–72 feet	18.9–21.9 meters
WC 167 Offshore Manifold Platform Bypass		
Length	700 feet	213 meters
Diameter	42 inches	107 centimeters
Fixed Seafloor Depth	46 feet	14 meters
UTOS/HIOS Pipeline System		
UTOS Diameter	42 inches	107 centimeters
UTOS Length	28.4 miles	45.7 kilometers
UTOS Depth (at time of installation)	3 feet below seafloor	0.9 meter
UTOS MAOP	1,250 pounds per square inch gage (psig)	86.2 bar
HIOS Diameter	42 inches	107 centimeters

Item	Description of Proposed Facilities	Metric Units (if applicable)
HIOS Length	57.4 miles	92.4
HIOS Depth (at time of installation)	3 feet below seafloor	0.9 meter
HIOS MAOP	1,440 psig	99.3 bar
Delfin Onshore Facility		
Pipeline Connecting Former UTOS Pipeline to New Metering Station (Length/Diameter)	0.25 mile of 42-inch-diameter	0.40 kilometer (km) of 107-inch-diameter
Pipeline Between Transco Station 44 and New Compressor Station Site (Length/Diameter)	Twin 0.6 mile of 30-inch-diameter	Twin 1.0 km of 76.2-centimeter-diameter
New Compressor Station	120,000 horsepower	89,484 kilowatt
Return to FERC-Jurisdictional Service (existing UTOS pipeline)	1.1 miles	1.8 kilometers
Port Delfin Offshore Air Emissions and Sources[1]		
Gas Turbines – Refrigeration Compressors	12	NA
Gas Turbines – Power Generation	12	NA
Acid Gas Recovery Unit Thermal Oxidizer	4	NA
Fugitive Emissions	NA	NA
Flares	12	NA
Marine essential generators	12	NA
Emergency generators	8	NA
Firewater pumps	8	NA
Port Delfin Operation Emissions – Nitrogen Oxide (NO_X)	4,335 tons per year (tpy)	NA
Port Delfin Operation Emissions – Carbon Monoxide (CO)	7,021 tpy	NA
Port Delfin Operation Emissions – Volatile Organic Compounds (VOC)	124 tpy	NA
Port Delfin Operation Emissions – Particulate Matter (PM_{10} and $PM_{2.5}$, each)	301 tpy	NA
Port Delfin Operation Emissions – Sulfur Dioxide (SO_2)	201 tpy	NA
Port Delfin Operation Emissions – Greenhouse Gases (as carbon dioxide equivalent emissions [CO_2e])	4,857,091 tpy	NA
Delfin Onshore Facility Air Emissions and Sources		
Gas Turbines – Compressors	4	NA
Electrical Generators	3	NA
Fuel Gas Heaters	4	NA
Blowdown Stack	1	NA
DOF Operation Emissions – Nitrogen Oxide (NO_X)	223.5 tpy	NA
DOF Operation Emissions – Carbon Monoxide (CO)	235.5 tpy	NA
DOF Operation Emissions – Volatile Organic Compounds (VOC)	26.5 tpy	NA
DOF Operation Emissions – Particulate Matter (PM_{10} and $PM_{2.5}$, each)	59.9 tpy	NA

[1] *Emission totals include safety zone emissions from LNGCs, tug operations, supply vessel, and helicopter.

Item	Description of Proposed Facilities	Metric Units (if applicable)
DOF Operation Emissions – Sulfur Dioxide (SO_2)	13.2 tpy	NA
DOF Operation Emissions – Greenhouse Gases (as CO_2e)	445,766 tpy	NA
Safety		
Safety Zone Around each TYMS (radius)	3,005 feet	916 meters
Safety Zone area each TYMS (acres)	651 acres	264 hectares
Combined Safety Zone areas (4 TYMS)	2,606 acres	1,054 hectares
Applicant proposed No Anchoring Area (NAA) and Area To Be Avoided (ATBA) (radius)	4,646 feet	1,416 meters
Applicant proposed NAA and ATBA area (acres)	1,557 acres	630 hectares
Combined Applicant proposed NAA and ATBA area (4 TYMS individual radial distances))	6,227 acres	2,520 hectares
Combined Applicant proposed NAA and ATBA area (4 TYMS incorporated into one zone)	10,784 acres	4,364 hectares
Number and Capacity of Lifeboats	1 @ 50 persons 4 @ 25 persons each 1 @ 6 persons	NA
Proposed Onshore Fabrication Sites		
Fabrication Site Locations	TBD; however, there would be no need for any new or expanded construction, laydown, or parking areas to construct the proposed Project.	NA

Common Conversion Equations

Unit	Conversion
Temperature	
°C	(°F - 32) / 1.8
°F	(°C x 1.8) + 32
Length / Distance	
1 inch	2.540 centimeters
1 inch	25.40 millimeters
1 foot	0.3048 meter
1 meter	3.2808 feet
1 meter	39.37 inches
1 mile	1.6093 kilometers
1 kilometer	0.6214 mile
1 mile	0.869 nautical mile
1 nautical mile	1.15 miles
Area	
1 ha	2.471 ac
1 ac	0.4047 ha
1 $foot^2$	0.0929 $meter^2$
1 $inch^2$	6.452 $centimeter^2$
1 $mile^2$	2.604 $kilometer^2$
1 $meter^2$	10.764 $feet^2$
Volumes, Weights, and Rates	
1 $foot^3$	7.4805 gallons
1 $foot^3$	0.02832 $meter^3$
1 $foot^3$	28.32 liters
1 gallon	0.134 $foot^3$
1 gallon	0.003785 $meter^3$
1 $meter^3$	264.172 gallons
1 $meter^3$	35.31 $feet^3$
1 $meter^3$	1,000 liters
1 gallon	3.785 liters
1 liter	0.2642 gallon
1 gallon	0.0238 bbl
1 $meter^3$	6.29 bbl

Unit	Conversion
1 MG	23,000 bbl
1,000 bbl	72.8 tonnes
1,000 bbl	5.614 $feet^3$
1,000 bbl	159 $meters^3$
1 pound	0.453592 kilogram
1 kilogram	2.205 pounds
1 kilogram	1,000 grams
1 ton	2,000 pounds
1 ton	0.9072 tonne
1 tonne	2,204.6 pounds
1 tonne	1.10231 tons
1 $foot^3$/second	0.28316 $meters^3$/second
1 $foot^3$/second	448.8 gallons/minute
1 $foot^3$/minute	7.4805 gallons/minute
1 million gallons per day	0.0438 $meter^3$/second
1 liter/minute	0.26417 gallons/minute
1 gallons per minute	4.54609 liters/minute
1 $meter^3$/hour	35.31 $feet^2$/hour
1 Bscf/d	0.028316 Bscm/d
1 Bscm/d	35.31 Bscf/d
metric tons/hour	1.1023 tons/hour
tons/hour	0.9072 metric tons/hour
1 tpy	907.18474 kilograms/year
1 foot/second	0.3048 meter/second
1 meter/second	3.2808 feet/second
1 meter/second	17.604 inch/second
1 milligram/liter	1 parts ppm (in water)
Volumes, Weights, and Rates	
1 Btu	2.9308 x 10-4 kW • hr
1 Btu	7.7816 x 102 ft-lbs
1 Btu	1005.056 J
1 Btu/SCF	37.33 kJ/Nm^3

Unit	Conversion
Power/Electricity	
1 kW	1.341 hp
1 hp	0.7457 kW
Pressure	
1 psi	0.0703 kg/m^3
1 kg/m^3	14.22 psi
1 psi	psig + atmospheric pressure
1 psig	0.0689 bar
Specific LNG, Gas, and Energy Conversions	
1 metric ton	14 bbl (LNG)
1 metric ton	2.23 meters^3 (LNG)
1 metric ton	78.6 feet^3 (LNG)
1 metric ton	52.11 MMBtu (energy)
1 bbl	0.071 metric tons (LNG)
1 bbl	0.16 meter^3 (LNG)
1 bbl	5.61 feet^3 (LNG)
1 meter^3	0.449 metric tons
1 meter^3	6.29 bbl (LNG)
1 meter^3	35.31 feet^3 (LNG)
1 meter^3	23.41 MMBtu (energy)
1 foot^3	0.013 tonnes (LNG)
1 foot^3	0.178 bbl (LNG)
1 foot^3	0.028 meter^3 (LNG)

List of Acronyms and Abbreviations

Acronym	**Full Name**
°C	degrees Celsius
°F	degrees Fahrenheit
72 COLREGS	Convention on the International Regulations for Preventing Collisions at Sea, 1972
ac	acre
ACHP	Advisory Council on Historic Preservation
ACQR	air quality control region
AIS	Automatic Identification System
APE	area of potential effects
Applicant	Delfin LNG, LLC
AQRV	Air Quality Related Value
ARM	Ambient Ratio Method
ARM2	Ambient Ratio Method 2
ARPA	Archaeological Resources Protection Act
ATBA	Area to be Avoided
ATON	Aids to Navigation
ATWS	additional temporary workspace
BA	Biological Assessment
BACT	Best Available Control Technology
bbl	barrel
BGEPA	Bald and Golden Eagle Protection Act
BMP	best management practice
BO	Biological Opinion
BOD	biological oxygen demand
BOEM	Bureau of Ocean Energy Management
B.P.	before present
Bscf/d	billion standard cubic feet
Bscf/yr	billion standard cubic feet per year
BSEE	Bureau of Safety and Environmental Enforcement
BTEX	benzene, ethylene, toluene and xylene
$Btu/hr/ft^2$	British thermal units per hour per square foot
BWMS	ballast water management system
CAA	Clean Air Act
CCS	carbon capture and sequestration
CEQ	Council on Environmental Quality
CFC	chlorofluorocarbon
CFR	Code of Federal Regulations
CG&MT Act	Coast Guard and Maritime Transportation Act of 2012
CH_4	methane
cm	centimeter
cm/s	centimeter per second
CMP	Coastal Management Program
CO	carbon monoxide
CO_2	carbon dioxide
CO_2e	carbon dioxide equivalent emissions
COARE	Coupled Ocean Atmosphere Response Experiment
COD	chemical oxygen demand

Acronym	**Full Name**
COMDTINST	Commandant Instruction
COTP	Captain of the Port
cSEL	cumulative sound exposure level
CTD	conductivity-temperature-depth
CUP	Coastal Use Permit
CWA	Clean Water Act
CY	calendar year
CZMA	Coastal Zone Management Act of 1972
dB	decibel
dBA	A-weighted decibel
dBL	linear decibels
dBpeak	peak sound pressure in decibels
DEHP	Bis(2-ethylhexyl)phthalate
Delfin LNG	Delfin LNG, LLC
Delfin LNG Procedures	Delfin LNG *Wetland and Waterbody Construction and Mitigation Procedures*
Delfin Port, or Port	Port Delfin LNG Project offshore facilities
DMR	dual mixed refrigerant
DO	dissolved oxygen
DOC	U.S. Department of Commerce
DOE	U.S. Department of Energy
DOE/FE	U.S. Department of Energy, Office of Fossil Energy
DOF	Delfin Onshore Facility
DOT	U.S. Department of Transportation
DP	dynamic positioning
DPS	Distinct Population Segment
DWPA	Deepwater Port Act of 1974
DWPSP	Deepwater Port Security Plan
EEZ	Economic Exclusion Zone
EFH	essential fish habitat
EIA	U.S. Energy Information Administration
EIS	Environmental Impact Statement
EO	Executive Order
ERL	effects range low
ERM	effects range medium
ESA	Endangered Species Act
ESD	emergency shutdown
FAA	Federal Aviation Administration
FAD	fish-aggregating device
FDMS	Federal Docket Management System
FEMA	Federal Emergency Management Agency
FERC Plan	FERC's *Upland Erosion Control Revegetation, and Maintenance Plan*
FERC	Federal Energy Regulatory Commission
FGB NMS	Flower Garden Banks National Marine Sanctuary
FHWG	Fisheries Hydroacoustic Working Group
FIRM	Flood Insurance Rate Map
FLNGV	floating liquefied natural gas vessel
FMP	Fishery Management Plan

Acronym	Full Name
FPE	Fairwood Peninsula Energy Corporation
FR	Federal Register
FRP	Facility Response Plan
FSA	Facility/Vessel Security Assessment
FSO	Facility/Vessel Security Officer
FSP	Facility/Vessel Security Plan
ft	feet
ft^2	square feet
ft^3	cubic feet
ft/s	feet per second
FTA	free trade agreement
Fugro	Fugro GeoServices, Inc.
g	factor of gravity
GARFO	Greater Atlantic Regional Fisheries Office
GBS	gravity-based structure
GDP	gross domestic product
GHG	greenhouse gas
GLO	General Land Office
GMFMC	Gulf of Mexico Fishery Management Council
gpm	gallon per minute
GPS	Global Positioning System
GRT	gross register tons
GWP	global warming potential
ha	hectare
HAP	hazardous air pollutant
HAPC	habitat area of particular concern
HIOS	High Island Offshore System
HMS	highly migratory species
HSD	Hydro Sound Damper
Hz	hertz
IFO	Intermediate Fuel Oil
IGC	International Gas Code
IGG	Inert Gas Generator
IMO	International Maritime Organization
IPCC	Intergovernmental Panel on Climate Change
IRA	Independent Risk Assessment
ISO	International Standards Organization
ISPS	International Ship and Port Facility Security
ISQG	interim sediment quality guidelines
kHz	kilohertz
km	kilometer
kW/m^2	kilowatts per square meter
LAC	Louisiana Administrative Code
La. R.S.	Louisiana Revised Statutes
LDAR	leak detection and repair
LDEQ	Louisiana Department of Environmental Quality
LDNR	Louisiana Department of Natural Resources
LDWF	Louisiana Department of Wildlife and Fisheries
L_{eq}	equivalent sound level
L_{dn}	day-night sound level

Acronym	**Full Name**
LFL	lower flammability limit
LNG	liquefied natural gas
LNGC	liquefied natural gas carrier
LNM	Local Notice to Mariners
m	meter
m^2	square meter
m^3	cubic meter
µg/L	microgram per liter
µm	micrometer
µPa	microPascal
µPa rms	microPascal root mean square
MAO	Maritime Administrative Order
MAOP	maximum allowable operating pressure
MARAD	Maritime Administration
MARPOL	International Convention for the Prevention of Pollution from Ships
MBTA	Migratory Bird Treaty Act
MDO	marine diesel oil
Mgal	million gallons
mgd	million gallons per day
mg/kg	milligram per kilogram
mg/L	milligram per liter
MLLW	mean lower low water
mm	millimeter
MMPA	Marine Mammal Protection Act
MMscf/d	million standard cubic feet per day
MMtpa	million metric tonnes per annum
MOA	Memorandum of Agreement
MOU	memorandum of understanding
MPA	Marine Protected Area
MPRSA	Marine Protection, Research, and Sanctuaries Act
MR	mixed refrigerant
m/s	meter per second
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	marine sanitation device
MSIB	Marine Safety Information Broadcasts
MTSA	Maritime Transportation Security Act of 2012
MW	megawatt
N_2O	nitrous oxide
NAA	No Anchoring Area
NAAQS	National Ambient Air Quality Standards
NAGPRA	Native American Graves and Protection and Repatriation Act
NAVD88	North American Vertical Datum of 1988
NEPA	National Environmental Policy Act of 1969
NETL	National Energy Technology Laboratory
NGA	Natural Gas Act
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NMS	Noise Mitigation Screen
NO_2	nitrogen dioxide
NOA	Notice of Availability

Acronym	**Full Name**
NOAA Fisheries	National Oceanic and Atmospheric Administration Fisheries Service
NODC	National Oceanographic Data Center
NOI	Notice of Intent
NO_x	nitrogen oxides
NPDES	National Pollutant Discharge Elimination System
NPS	National Park Service
NRCS	National Resource Conservation Service
NRHP	National Register of Historic Places
NSA	noise sensitive area
NSR	New Source Review
NTL	Notice to Lessees
OCM	Office of Coastal Management
OCS	Outer Continental Shelf
OPA	Oil Pollution Act
OSV	offshore supply vessel
P&MD	Louisiana Office of Coastal Management, Permits and Mitigation Division
Pa	Pascal
PADD	Petroleum Administration for Defense District
PAH	polycyclic aromatic hydrocarbon
PCB	polychlorinated biphenyls
PEL	probable effects level
PEM	palustrine emergent
PERT	Program Evaluation Review Technique
pga	peak ground acceleration
PHMSA	Pipeline and Hazardous Materials Safety Administration
PM	particulate matter
$PM_{2.5}$	particulate matter with an aerodynamic diameter less than or equal to 2.5 microns
PM_{10}	particulate matter with an aerodynamic diameter less than or equal to 10 microns
Port	Delfin Port
ppm	parts per million
ppth	parts per thousand
Project	Port Delfin LNG Project
psig	pounds per square inch gauge
PSD	Prevention of Significant Deterioration
PSO	Protected Species Observer
PSI	PSI Midstream Partners, L.P.
PSS	palustrine scrub/shrub
psu	practical salinity units
PTS	permanent threshold shift
Pub. L.	Public Law
RACON	radar beacon
RCRA	Resource Conservation and Recovery Act
rms	root mean square
RO	reverse osmosis
ROD	Record of Decision
ROI	Region of Influence

Acronym	**Full Name**
RPT	rapid phase transition
RV	recreational vehicle
Sandia	Sandia National Laboratory
SEAMAP	Southeast Area Monitoring and Assessment Program
SEL	sound exposure level
SERO	Southeast Regional Office
SHPO	State Historic Preservation Office
SIL	Significant Impact Level
SIP	state implementation plan
SMR	single mixed refrigerant
SNWW	Sabine-Neches Waterway
SO_2	sulfur dioxide
SOLAS	Safety of Life at Sea
SPCC	spill prevention, control, and countermeasures
SPL	sound pressure level
SPL_{pk}	peak sound pressure level
SPL_{rms}	root mean square (90%) sound pressure level
SVM	service vessel mooring
SVOC	semi-volatile organic compound
SWPPP	Stormwater Pollution Prevention Plan
TAL	Target Analyte List
TCDD	2,3,7,8 tetrachloro-p-dibenzodioxin
Tcf	trillion cubic feet
TCL	target compound list
TDS	total dissolved solids
TEF	Toxic Equivalency Factor
TEL	threshold effects level
TEQ	toxicity equivalency quotient
TL	transmission loss
TOC	total organic carbon
Transco	Transcontinental Gas Pipe Line Company, LLC
TSP	total suspended particulate
TSS	total suspended solids
TTS	temporary threshold shift
TWS	temporary workspace
TYMS	tower yoke mooring system
UFL	upper flammability limit
UPI	Universal Pegasus International
U.S.C.	United States Code
USACE	U.S. Army Corp of Engineers
USCG	U.S. Coast Guard
USDOI	U.S. Department of the Interior
USEPA	U.S. Environmental Protection Agency
USFWS	U.S. Fish and Wildlife Service
USGCRP	U.S. Global Change Research Program
UTOS	U-T Offshore System
VHF	very high frequency
VOC	volatile organic compound
VTS	Vessel Traffic Services
WC	West Cameron Block

Acronym	**Full Name**
WET	whole effluent toxicity testing
WFA	weighting factor adjustment
ZA	zone of avoidance
ZOI	zone of influence

1.0 INTRODUCTION

On May 8, 2015, Delfin LNG, LLC (hereinafter referred to as Delfin LNG or the Applicant), a wholly owned subsidiary of Fairwood Peninsula Energy Corporation (FPE), submitted an application to the U.S. Coast Guard (USCG) and Maritime Administration (MARAD) seeking a Federal license under the Deepwater Port Act of 1974 (DWPA), as amended, to own, construct, and operate a deepwater port for the liquefaction and export of liquefied natural gas (LNG) in Federal waters off the coast of Cameron Parish, Louisiana. The proposed deepwater port would be the first of its kind offshore terminal operated for the purpose of exporting LNG to the global market. Natural gas would be delivered to four moored floating LNG vessels (FLNGVs) through two existing offshore natural gas pipelines of the former U-T Offshore System (UTOS)[2] and the High Island Offshore System (HIOS)[3]. Concurrent with their application for the deepwater port, Delfin LNG submitted an application with the Federal Energy Regulatory Commission (FERC) requesting authorizations pursuant to Section 7(c) of the Natural Gas Act (NGA) and 18 Code of Federal Regulations (CFR) Part 157 to construct and operate the onshore facilities necessary for the proposed Project. Delfin LNG submitted a supplement to the application on June 19, 2015, which was deemed complete on June 29, 2015. On September 17, 2015, Delfin LNG provided notice of its intent to submit a full amended application as a result of further technical design work and additional economic analysis increasing liquefaction capacity. Delfin LNG filed an amended application with the USCG, MARAD, and FERC on November 19, 2015. The proposed Port Delfin LNG Project (Delfin LNG Project or Project) was assigned a USCG Docket No. USCG-2015-0472 and FERC Docket No. CP15-490-000. In addition, on November 19, 2015, HIOS filed an application with FERC pursuant to section 7(b) of the NGA and 18 CFR Part 157 to abandon its offshore facilities in the Gulf of Mexico, including its 66-mile, 42-inch-diameter mainline, a 42-inch[4] pig launcher at High Island Block 264, and its platform at WC 167. The application for abandonment was assigned FERC Docket No. CP16-20-000, subsequently amended to CP15-490-001.

The vertical line in the margin identifies text that has been modified in this final EIS and differs substantially from the corresponding text in the draft EIS.

Together, the USCG and MARAD are the lead Federal agencies responsible for licensing of the proposed Port. FERC is the lead cooperating Federal agency responsible for review of the onshore natural gas pipeline and associated aboveground components, and the HIOS facility abandonment. In accordance with Section 1504(f) of the DWPA and Section 7(c) of the NGA, this final Environmental Impact Statement (EIS) has been prepared in cooperation with additional Federal agencies and departments to comply with the requirements of the National Environmental Policy Act of 1969 (NEPA), and such compliance shall fulfill the NEPA responsibilities of such agencies and departments related to the licensing and review of the proposed Project and the requirements of NEPA, the DWPA and the NGA, USCG Commandant Instruction (COMDTINST) M16475.1D, and the Department of Homeland Security Management Directive 23-01, Environmental Planning Program, and the U.S. Department of Transportation (DOT) Order 5610.1C, "Procedures for Considering Environmental Impacts," and Maritime Administrative Order (MAO) 600-1, "Procedures for Considering Environmental Impacts." The U.S. Department of Energy (DOE), U.S. Department of the Interior (USDOI) Bureau of Ocean Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE), U.S. Fish and

[2] The UTOS naming convention is retained for ease of reference but technically describes the "former UTOS" pipeline system which no longer exists as a legal entity and is now owned by Delfin Offshore Pipeline, LLC, a wholly owned subsidiary of Delfin LNG, LLC, "the Applicant."

[3] The Applicant proposes to use a portion of the existing HIOS pipeline from West Cameron Block 167 to High Island Block (HI) A264 under a Pipeline Services Agreement with HIOS.

[4] See the Common Conversion Equations table on p. xxvi of this final EIS for metric or other equivalents where not otherwise provided in the text.

Wildlife Service (USFWS), National Oceanic and Atmospheric Administration Fisheries Service (NOAA Fisheries; also known as National Marine Fisheries Service [NMFS]), U.S. Army Corps of Engineers (USACE), U.S. Environmental Protection Agency (USEPA), and the U.S. Department of Transportation Pipeline and Hazardous Materials Safety Administration (PHMSA) are cooperating agencies for the purpose of this final EIS. They may incorporate the subsequent final EIS in their permitting processes.

The DWPA establishes a licensing system for ownership, construction, and operation of deepwater ports in waters beyond the territorial limits of the United States. Originally, the DWPA promoted the construction and operation of deepwater ports as a safe and effective means of importing oil into the United States and transporting oil from the Outer Continental Shelf (OCS), while minimizing tanker traffic and associated risks close to shore. The Maritime Transportation Security Act of 2012 (MTSA) amended Section 3(9)(A)[5] to insert the words “or from” before the words “and State” in the definition of a deepwater port to grant MARAD the authority to license the construction of deepwater ports for the export of oil and natural gas from domestic sources within the United States to foreign global markets.

Under the DWPA, all deepwater ports must be licensed by the Secretary of Transportation (Secretary). The Secretary has delegated authority to the USCG and MARAD to process applications submitted by private parties to construct, own and operate deepwater ports. The USCG retains this responsibility under the Department of Homeland Security. On June 18, 2003, the Secretary delegated authority to MARAD to issue, transfer, amend, or reinstate a license for the construction and operation of a deepwater port. The responsibility for preparing the Project Record of Decision (ROD) and for issuing or denying the Deepwater Port License has also been delegated to MARAD. Hereafter, "the Secretary" refers to the Maritime Administrator as the delegated representative of the Secretary. On April 30, 2013, MARAD issued a Notice of Policy Clarification Concerning the Designation of Adjacent Coastal States for Deepwater Port License Applications advising the public that nautical miles shall be used when determining Adjacent Coastal State status. Pursuant to the criteria provided in the Act, Louisiana and Texas are the Adjacent Coastal States for the proposed Project. Other states may apply for Adjacent Coastal State status in accordance with 33 United States Code (U.S.C.) 1508(a)(1).

On July 16, 2015, the MARAD issued a Notice of Application in the Federal Register,[6] summarizing the Applicant’s deepwater port application. Under procedures set forth in the DWPA, the USCG and MARAD have 240 days from the date of the Notice of Application to hold one or more public license hearings in the adjacent coastal State(s).

On September 18, 2015, the USCG and MARAD issued a letter to suspend the statutory timeline required by the DWPA, commencing on September 18, 2015, and ending on December 24, 2015, with the issuance of a Request for Comments.[7] This timeline suspension was issued to account for the Applicant’s development of an amended DWPA license application.

On March 7, 2016, the USCG and MARAD issued another letter to suspend the statutory timeline required by the DWPA, commencing on March 7, 2016, and ending on July 8, 2016. These periods of suspension were not counted in determining the date prescribed by the time limits set forth in 33 U.S.C. 1504(g) and 1504(i)(4) of the DWPA.

The Applicant also filed permit applications required under the Clean Water Act (CWA) (Section 10/404) on November 11, 2015. The Applicant has prepared draft permit applications required under the Clean Air Act (CAA), but has not yet filed the permit application. An official permit application required under the CAA would be filed prior to construction. Additional permits are discussed in Section 1.5 of this final EIS.

[5] 33 U.S.C. 1502(9)(A).
[6] Vol. 80, Federal Register, No. 136, Thursday, July 16, 2015, pp 42162-65.
[7] Vol. 80, Federal Register, No. 247, Thursday, December 24, 2015, pp 80455-56.

The proposed Project has both onshore and offshore components. The proposed deepwater port would be located in Federal waters of the Gulf of Mexico, approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 feet (ft). Figure 1-1 shows the general location of the proposed Project. The proposed Port would reuse and repurpose two existing offshore natural gas pipelines—the former UTOS pipeline and the HIOS pipeline—to transmit natural gas sourced from the onshore interstate pipeline grid to the offshore deepwater port. In addition to the existing UTOS and HIOS pipeline systems, the proposed Port facilities contained in the USCG and MARAD license application would consist of:

- four semi-permanently moored FLNGVs;
- four disconnectable tower yoke mooring systems (TYMS);
- four pipeline riser components;
- four service vessel mooring points;
- four 30-inch-diameter pipeline laterals, each approximately 6,400 ft in length; and
- one 700-ft, 42-inch-diameter bypass around existing West Cameron block 167 offshore manifold platform (WC 167) to connect the HIOS and UTOS pipelines.

The proposed Delfin Onshore Facility (DOF) would be located in Cameron Parish, Louisiana, and would be certificated by the FERC under a separate permitting process (see FERC Docket No. CP15-490-000). The proposed DOF would consist of:

- use of approximately 1.1 miles of existing UTOS pipeline;
- construction of new 120,000 horsepower (hp) compressor station, and associated metering and regulation facilities; and
- installation of new supply header pipelines inclusive of 0.25 mile of new 42-inch pipeline connecting the former UTOS pipeline to the new metering station and 0.6 mile of new twin 30-inch pipelines between Transco Station 44 and the new compressor station site.

Gas to be delivered to the FLNGVs would originate at the proposed DOF in Cameron Parish, Louisiana. Delfin LNG would use two existing and underutilized 42-inch outside-diameter pipelines to be interconnected by a new bypass at WC 167 and new offshore laterals to connect the existing pipelines to the FLNGVs, which would be moored to a disconnectable TYMS. Each TYMS would consist of a pile jacket structure connected to a manifold deck module and turntable deck module, with an attached swivel stack. It is anticipated that each mooring structure would require the installation of four driven piles (approximately 78 inches in diameter by 300 ft in length; subject to change during detailed engineering design), one for each leg. Four new-build, custom-designed FLNGVs would be moored to each disconnectable TYMS, allowing these vessels to weathervane or freely rotate around the TYMS structure to best respond to changing wind and weather conditions. The feed gas would be processed through a gas metering system, also known as a metering skid, for validation and custody transfer of the gas into the system and sent for pretreatment and liquefaction. Natural gas would be liquefied and stored on the FLNGVs until delivered to LNG carriers (LNGCs) via ship-to-ship transfer through offloading arms and cryogenic hoses, which would be able to accommodate all relative motions between the LNGC and FLNGV during cargo transfer. The four FLNGVs would be capable of producing a nominal capacity of 12.0 million metric tonnes per annum (MMtpa) of LNG, or 3.0 MMtpa each. Each FLNGV would include gas pretreatment and three liquefaction trains having a nominal capacity of 1.0 MMtpa each, providing the nominal capacity of 3.0 MMtpa. A single FLNGV would have an LNG storage capacity of approximately 210,000 cubic meters (m^3). The offloading system would be capable of accommodating LNGCs with nominal cargo capabilities ranging between 125,000 and 177,000 m^3. The FLNGVs would use air cooling to support the LNG liquefaction process, and would be capable of generating all its required electrical power, and producing and storing on board demineralized water, freshwater, and potable water for process and other requirements.

Detailed descriptions of the Proposed Action are provided in Section 2.1.

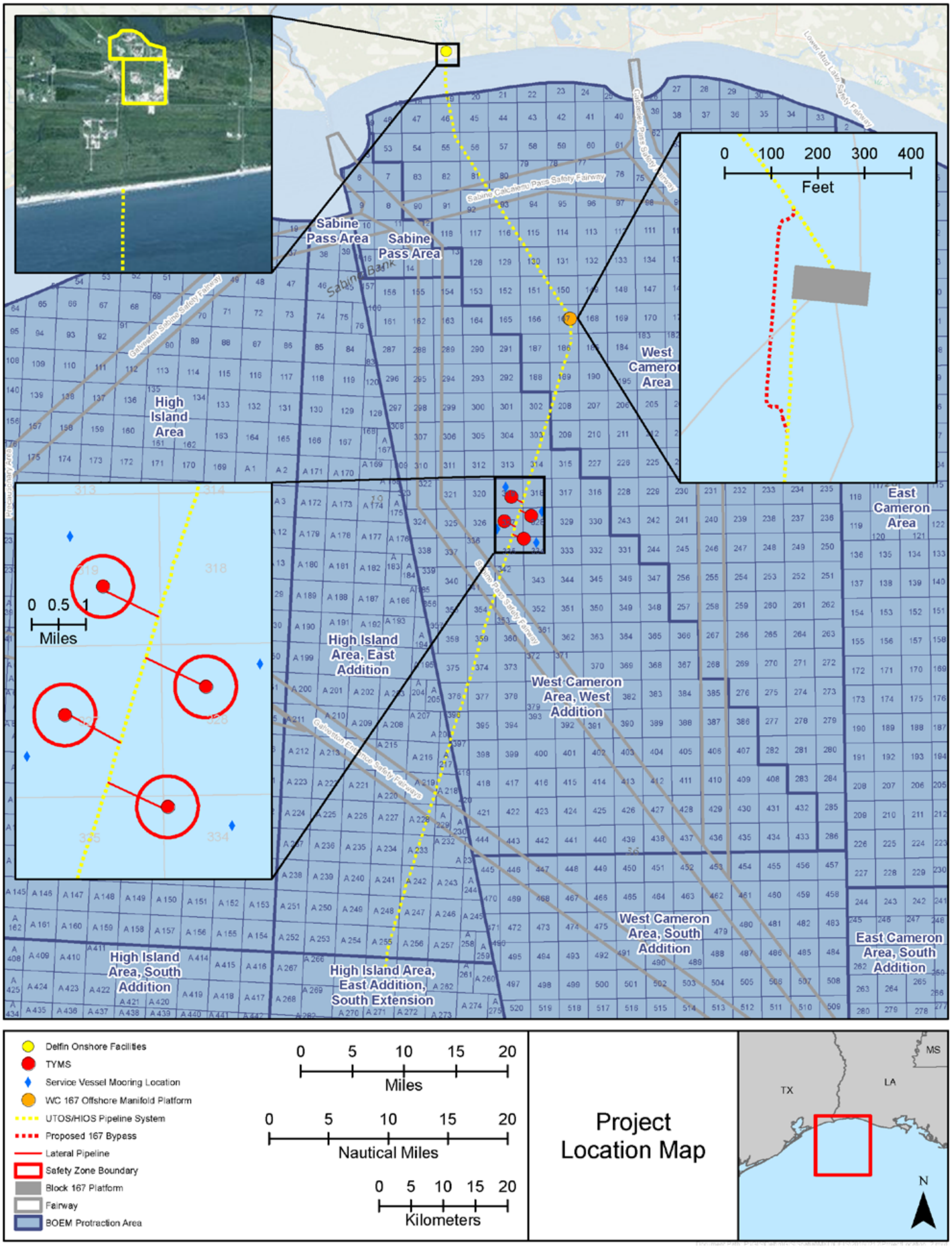

Figure 1-1. Project Location Map

1.1 Deepwater Port Regulatory Criteria

The DWPA of 1974, as amended, was passed to promote and regulate the construction and operation of deepwater ports as a safe and effective means of importing and exporting oil or natural gas. The DWPA requires the Secretary to approve or deny a deepwater port license application. In reaching this decision, the Secretary must carry out the Congressional intent expressed in the DWPA, which is to:

- "authorize and regulate the location, ownership, construction and operation of deepwater ports in waters beyond the territorial limits of the United States;
- provide for the protection of the marine and coastal environment to prevent or minimize any adverse impact that might occur as a consequence of the development of such ports;
- protect the interests of the United States and those of adjacent coastal States in the location, construction, and operation of deepwater ports;
- protect the rights and responsibilities of the States and communities to regulate growth, determine land use, and otherwise protect the environment in accordance with law;
- promote the construction and operation of deepwater ports as a safe and effective means of importing oil and natural gas into the United States and transporting oil and natural gas from the outer continental shelf while minimizing tanker traffic and the risks attendant thereto; and
- promote oil and natural gas production on the outer continental shelf by affording an economic and safe means of transportation of outer continental shelf oil and natural gas to the United States mainland."

The Congressional intent is codified in nine requirements set forth in 33 U.S.C. 1503(c), as follows:

- The Applicant is financially responsible and will meet the requirements of the DWPA.
- The Applicant can and will comply with applicable laws, regulations, and license conditions.
- Construction and operation of the deepwater port will be in the national interest and consistent with national security and other national policy goals and objectives, including energy sufficiency and environmental quality.
- The deepwater port will not unreasonably interfere with international navigation or other reasonable uses of the high seas, as defined by treaty, convention, or customary international law.
- The Applicant has committed to the deepwater port being constructed and operated using best available technology, so as to prevent or minimize adverse impact on the marine environment.
- The Secretary has not been informed, within 45 days of the last public hearing on a proposed license for a designated application area, by the Administrator of the Environmental Protection Agency that the deepwater port will not conform with all applicable provisions of the Clean Air Act, as amended (42 U.S.C. 7401 et seq.); the Federal Water Pollution Control Act, as amended (33 U.S.C. 1251 et seq.); or the Marine Protection, Research and Sanctuaries Act, as amended (16 U.S.C. 1431 et seq., 1447 et seq.; 33 U.S.C. 1401 et seq., 2801 et seq.).
- The Secretary has consulted with the Secretaries of the Army, State and Defense to determine their views on the adequacy of the application, and its effect to programs within their respective jurisdictions.
- The Governor of the adjacent coastal State approves, or is presumed to approve, issuance of the license.
- The adjacent coastal State to which the deepwater port is to be directly connected by pipeline has developed, or is making at the time the application is submitted, reasonable progress, toward developing an approved coastal zone management program pursuant to the Coastal Zone Management Act (CZMA) of 1972 (16 U.S.C. 1451 et seq.).

On December 20, 2012, the Coast Guard and Maritime Transportation Act of 2012 (Public Law [Pub. L.] 112–213, Sec. 312 (Dec. 20, 2012) (CG&MT Act) amended Section 3(9)(A) (33 U.S.C. 1502(9)(A)) of the DWPA and brought offshore export facilities within the definition of a deepwater port. Accordingly, MARAD, with the concurrence of the USCG, intends to use the existing deepwater port regulations for the review, evaluation, and processing of any deepwater port license application involving the export of oil or natural gas from domestic sources within the United States as provided for in 33 CFR parts 148, 149 and 150.[8]

1.1.1 LNG Export Authorization

A deepwater port license issued by MARAD does not, by itself, convey an authorization to export natural gas. Exports of natural gas, including LNG, will require authorization from the DOE pursuant to Section 3 of the NGA of 1938, as amended. MARAD licenses the deepwater port facility. Any deepwater port applicant who proposes to export natural gas from domestic sources within the United States must submit an export-specific comprehensive license application conforming to all established and applicable deepwater port licensing requirements and regulations. Complete applications to the DOE requesting authority to export LNG to countries with which the United States has a free trade agreement (FTA) requiring national treatment for trade in natural gas (FTA countries) are approved without modification or delay pursuant to NGA section 3(c). For applications to the DOE requesting authority to export LNG to countries that do not have an FTA requiring national treatment for trade in natural gas (non-FTA countries), the DOE conducts a full public interest review, including determining potential effects of additional exports on the economy (GAO 2014). While Section 3(a) of the NGA establishes a broad public interest standard and a presumption favoring export authorizations, the statute neither defines "public interest" nor identifies criteria that must be considered. In prior decisions, however, the DOE has identified a range of factors that it evaluates when reviewing an application for export authorization. These factors include:

- economic impacts of LNG exports,
- security of natural gas supply,
- international considerations, and
- environmental considerations, among others.

These criteria are not exclusive. Applicants and interveners in DOE proceedings are also free to raise new issues or concerns relevant to the public interest that may not have been addressed in prior cases. To conduct its review, DOE looks to record evidence, including macroeconomic studies that DOE may commission to evaluate the impact of United States (U.S.) LNG exports on the U.S. economy.

On February 20, 2014, the DOE, Office of Fossil Energy (DOE/FE), in accordance with Section 3(c) of the NGA, as amended by Section 201 of the Energy Policy Act of 1992 (Pub. L. 102-486), authorized Delfin LNG to export domestically produced LNG to FTA countries up to 657.5 billion cubic feet annually. Additionally, the DOE/FE has found, in prior non-FTA LNG export authorizations, that U.S. LNG exports can diversify global LNG supplies and, thereby, increase energy security for many U.S. allies and trading partners. Currently, Delfin LNG's non-FTA export application is pending before the DOE/FE, and will not be addressed until completion of the USCG and MARAD environmental review process, and the Secretary has issued the Project ROD (GAO 2014).

1.2 Purpose and Need

The DWPA application currently under consideration is one proposed by Delfin LNG. In its application, Delfin LNG proposes to construct, own, and operate the proposed Project to transport natural gas from the existing natural gas transmission infrastructure to an offshore deepwater port for liquefaction and export to LNGCs via ship-to-ship transfer for delivery to foreign global markets. The purpose of the proposed

[8] Volume 80, Federal Register, No. 88, Thursday, May 7, 2015, p 26321.

Project is to provide a safe and reliable facility to liquefy natural gas for export to FTA and non-FTA countries. The proposed Project would meet the Delfin LNG objective to provide for an efficient and cost-effective outlet for exports of LNG produced from U.S. domestic natural gas available in the marketplace. The Applicant seeks to develop the proposed Project in the Gulf of Mexico to take advantage of existing natural gas infrastructure both onshore and offshore, the availability of interconnections to interstate natural gas pipelines, an existing natural gas industry workforce, and the ready availability of vessel support services. The proposed Project would be a tolling export terminal. As a tolling export terminal, upstream suppliers of natural gas have the right to deliver gas to the terminal for liquefaction services and to receive LNG in exchange for a processing fee, and have the LNG transferred to an LNGC for export to the destination port. Such tolling arrangement removes the export terminal's exposure to so-called "molecule risk" – the risk of owning gas that changes value as prices move up and down. Because of this arrangement, Delfin LNG would not exercise ownership of the natural gas, would not be responsible for obtaining the gas supply, and would only provide liquefaction and export services and facilities on a contract basis to its customers. The size of traditional and emerging natural gas supply sources in proximity to the proposed Project and available through the integrated natural gas pipeline system would provide the Applicant's potential customers with diverse and reliable alternative gas supply options on a long-term basis.

On February 20, 2014, the DOE/FE, in accordance with Section 3(c) of the NGA, authorized Delfin LNG to export domestically produced LNG to FTA nations up to 657.5 billion cubic feet annually. The DOE/FE must also meet its obligation to process the pending Delfin LNG application to export LNG to non-FTA countries under Section 3(a) of the NGA, which requires the DOE/FE to authorize the export of LNG to non-FTA countries unless the DOE/FE finds that the export is not consistent with the public interest.[9] Additionally, the DOE/FE has found, in prior non-FTA export authorizations, that U.S. exports can diversify global LNG supplies and, thereby, increase energy security for many U.S. allies and trading partners. Currently, Delfin LNG's non-FTA export application is pending before the DOE/FE, and will not be addressed until completion of the USCG and MARAD environmental review process.

Growth in domestic natural gas resources has made the potential for increased natural gas export a possibility. The U.S. Energy Information Administration (EIA) has reported a nearly 10 percent increase in domestic "proved reserves" of natural gas (EIA 2015a). "Proved reserves" in the EIA's data are defined as "estimated volumes of hydrocarbon resources that analysis of geologic and engineering data demonstrates with reasonable certainty [of 90% or more] are recoverable under existing economic and operating conditions." The EIA estimates that the United States holds 388.8 trillion cubic feet (Tcf) in proved reserves of natural gas, a 9.8 percent increase over the proved reserves estimate of 2013 (EIA 2015a). Over this same period, natural gas imports have declined by approximately 6 percent (EIA 2015a). The EIA predicts that the United States will transition from a modest net importer of 1.3 Tcf of natural gas to a net exporter by 2017, with net exports of a potential range of 3.0 Tcf to 13.1 Tcf by 2040 (EIA 2015b).

Low U.S. natural gas prices relative to other global markets have increased interest in exporting domestically produced natural gas (FERC 2015a). With increased proved reserves of natural gas coupled with decreased domestic prices and increasing global demand, there continues to be a significant demand for U.S.-sourced LNG. Increased access to U.S. gas would not only provide new supplies to America's allies around the world, it would also position the country as a reliable and secure alternative to traditional pipeline natural gas suppliers in Russia and the Middle East. The Applicant has engaged in discussions with potential, international LNG off-takers that would enter into tolling agreements to acquire

[9] On November 12, 2013, Delfin LNG LLC submitted an application to the DOE/FE requesting long-term authorization to export LNG in a volume equivalent to 657.5 billion cubic feet per year to non-FTA countries in DOE/FE Docket No. 13-147-LNG. These non-FTA LNG export volumes are not additive to the FTA LNG export volumes previously authorized by the DOE/FE.

liquefaction services from the proposed Project. As stated earlier, the DOE/FE is still evaluating whether LNG exports to non-FTA countries are in the public interest, and has commissioned several studies on potential economic impacts, including the 2014 EIA LNG Export Study (EIA 2014a) and the 2015 LNG Export Study (DOE 2015) as part of its evaluation. The most recent of these economic studies were open to public comment through February 12, 2016. These studies indicate the macroeconomic impacts of higher LNG exports are positive in all scenarios evaluated.

1.3 Scope and Organization of the Final EIS

In processing DWPA applications, the Secretary (through USCG and MARAD) is responsible for complying with numerous Federal and State regulations, including NEPA. As such, the purpose of this final EIS is to provide an environmental analysis sufficient to support the Secretary's licensing decision; to facilitate a determination of whether Delfin LNG has demonstrated that the proposed Project would be located, constructed, operated, and, eventually upon retirement, decommissioned, using the best available technology necessary to prevent or minimize adverse impacts on the environment; and to encourage and facilitate involvement by the public and interested agencies in the environmental review process.

The affected environmental resource areas evaluated in this final EIS include water quality, biological resources, threatened and endangered marine mammals, sea turtles, fish and birds, geological resources, cultural resources, ocean uses, land uses, recreation and visual resources, socioeconomics, transportation, air quality, noise, and public safety. This final EIS describes the Proposed Action and potential alternatives (Section 2.0), the affected environment as it currently exists (Section 3.0), the probable environmental consequences that may result from construction, operation, and decommissioning of the proposed Project (Section 4.0), public safety (Section 5.0), and cumulative and other impacts (Section 6.0). Sections 3.0 and 4.0 are split between onshore and offshore components of the proposed Project to allow for more focused agency review at the Federal and State level.

Where applicable, this final EIS considers safety but does not function as the final safety evaluation. All aspects of port safety will be addressed in the Port Operations Manual, which would require USCG approval prior to initiation of deepwater port operations.

Financial responsibility is being evaluated within MARAD as a separate task that will be considered along with the final EIS as part of the final licensing decision.

USCG and MARAD's authority under the DWPA is limited to approval or denial of deepwater port license applications as discussed in Section 1.1. Additionally, FERC's authority under the NGA relates only to natural gas facilities that are involved in interstate commerce. Thus, the facilities associated with the production of natural gas are not under USCG, MARAD, or FERC jurisdiction.

In developing this final EIS, the USCG, MARAD, and FERC adhered to the procedural requirements of NEPA, the Council on Environmental Quality (CEQ) regulations for implementing NEPA (40 CFR 1500-1508), Department of Homeland Security Management Directive 23-01, Environmental Planning Program, USCG procedures for implementing NEPA (COMDTINST M16475.1D, National Environmental Policy Act Implement Procedures and Policy for Considering Environmental Impacts), the USCG's final rule for deepwater ports for LNG, as well as the DOT and MARAD procedures for considering environmental impacts (DOT Order 5610.1C and MAO 600-1), and FERC's regulations at 18 CFR Part 380.

1.4 Public Review and Comment

Agency and public participation in the NEPA process promotes open communication between the public and the government and enhances decision-making. All persons and organizations having a potential interest in the Secretary's decision whether to grant the license are encouraged to participate in the decision-making process.

The USCG and MARAD initiated the public scoping process on July 29, 2015, with the publication of a Notice of Intent (NOI) to prepare an EIS in the Federal Register[10]. The NOI included information on public meetings and informational open houses; requested public comments on the scope of the EIS; and provided information on how the public could submit comments by mail, hand delivery, facsimile, or electronic means. The closing date of August 28, 2015, was set for receipt of materials in response to the request for comments on the proposed Project. The NOI also announced the establishment of a public docket, accessible through the Federal Docket Management System (FDMS) website: http://www.regulations.gov under docket number USCG-2015-0472.

An Interested Party Letter, the NOI published in the Federal Register, and a fact sheet describing the proposed Project were sent to Federal, State, and local agency representatives; and other potentially interested parties (Appendix A). Public comments submitted as part of the scoping process were considered during the development of the draft EIS.

As an additional mechanism to facilitate public participation in the scoping process, the USCG and MARAD held an informational open house in Lake Charles, Louisiana, on August 18, 2015, and in Beaumont, Texas, on August 19, 2015. The open houses were attended by 27 recorded individuals (Louisiana: 14; Texas: 13). At the Lake Charles, Louisiana, meeting, one individual provided oral comments and one individual provided oral comments at the Beaumont, Texas meeting. No written comments were submitted at either of the meeting locations.

In response to Delfin LNG's intention to amend its deepwater port application, the USCG and MARAD suspended the timeline for processing the application on September 18, 2015. On November 19, 2015, Delfin LNG submitted its amended application to the USCG and MARAD. Due to the significant and substantive changes between the original and amended applications, the USCG and MARAD determined it was necessary to provide Federal and State agencies another opportunity to review the Delfin LNG application. The 240-day statutory timeline for processing the Delfin LNG application was reset to zero. A Notice of Receipt of Amended Application was published in the Federal Register on December 24, 2015[11], re-initiating the public comment period. The closing date of January 19, 2016, was set for receipt of materials in response to the request for comments on the proposed Project. A total of 10 submissions from Federal and State agencies, 4 submissions from Native American Tribes, 1 submission from companies and organizations, and 1 submission from individuals were received on the FDMS Docket, as of May 20, 2016.

FERC has established a publicly accessible docket, Docket No. CP15-490-000 (see 80 FR 30226, May 27, 2015) to receive and post matters related to the Delfin LNG project. The FERC initiated their public scoping process by issuing a *Notice of Scoping for the Proposed Delfin LNG Project and Request for Comments on Environmental Issues* for Docket No. CP15-490-000 on December 24, 2015[12]. In a related docket (CP16-20-000), FERC published a *Notice of Application* on December 7, 2015 regarding the abandonment of the HIOS system pursuant to Section 7(b) of the NGA and Part 157 of FERC's regulations[13]. As a cooperating agency, the FERC will play an important role in developing the environmental analysis for the FERC-jurisdictional facilities in the EIS. Thus, FERC staff will work with USCG and MARAD staff and contractors to ensure that the proposed DOF is thoroughly evaluated and that all scoping comments received are addressed, as appropriate, in the EIS. FERC staff will also evaluate reasonable alternatives to the proposed Project, and make recommendations on how to lessen or avoid impacts on various resource areas.

[10] Vol. 80, Federal Register, No. 145, Wednesday, July 29, 2015, pp. 45270-74.
[11] Vol. 80, Federal Register, No. 247, Thursday, December 24, 2015, pp. 80455-80456.
[12] Vol. 80, Federal Register, No. 2, Tuesday, January 5, 2016, pp. 231-233
[13] Vol. 80, Federal Register, No. 234, Monday, December 7, 2015, pp. 76007-76009

As of August 25, 2016, a total of 4 submissions from Federal and State agencies, 2 submissions from Native American Tribes, and 3 submissions from companies and organizations were received on the FERC docket. In addition, 15 requests for intervenor status, of which 9 also included protests, were filed on the two FERC dockets (CP15-490-000; CP16-20-000).

The USCG and MARAD issued a Notice of Availability (NOA) in the Federal Register on July 15, 2016, announcing the availability of the draft EIS for public review (Appendix B).[14] The NOA included information on public meetings and informational open houses; requested public comments on the draft EIS; and provided information on how the public could submit comments by mail, hand delivery, facsimile, or electronic means. The comment period ended on August 29, 2016. Public comments submitted as part of the public comment process were considered during the development of this final EIS and are included with individual responses in Appendix C.

To facilitate public participation in the EIS process, the USCG, MARAD, and FERC held public meetings in Cameron, Louisiana, on August 9, 2016, and Beaumont, Texas, on August 10, 2016. Both public meetings were preceded by an informational open house. The public meetings were attended by 34 recorded individuals (Louisiana: 22; Texas: 12). Five people provided oral comments at each of the public meetings, all in support of the proposed Project. A total of 4 submissions from federal agencies, 1 submission from a state agency, 2 submissions from non-governmental organizations, and 2 submissions from individuals were received on the FDMS Docket.

Comments received on the public docket from the Center for Biological Diversity (letters dated August 28, 2015 and August 29, 2016) noted that the EIS should address the indirect impacts of induced natural gas development. However, the scope of this EIS for the proposed Project does not include the production of natural gas. The scope of this final EIS focuses on the direct and indirect impacts of LNG facilities that are subject to MARAD's Federal action, the licensing of an LNG facility, and the reasonably foreseeable Federal actions of cooperating agencies, including but not limited to FERC (certificating onshore components of the proposed Project) and USEPA (permits under the CWA and CAA).

As stated in response to comments from the Center for Biological Diversity discussed above, the scope of this EIS focuses on the direct and indirect impacts of the proposed LNG facility that is subject to MARAD's Federal action, the licensing of the construction and operation of the LNG facility, and the Federal actions of cooperating agencies, including but not limited to the FERC (certificating onshore components of the LNG facility) and USEPA (permitting under the CWA and CAA). In response to the review of the draft EIS, a comment received from the USEPA (by letter dated August 29, 2016) recommended that the final EIS include an estimation of greenhouse gas (GHG) emissions associated with the production, transportation, and combustion of the natural gas proposed to be exported. While this EIS does include an estimation of GHG emissions related to construction, operation, and decommissioning activities, it does not include an analysis of upstream effects from potential induced production or downstream effects from the export of natural gas.

For this Project, Delfin LNG proposes to receive natural gas through its interconnection with other existing natural gas pipelines. The factors described under CEQ regulations for a meaningful analysis—including when, where, and how natural gas development would occur as related to the proposed project—are unknown.[15] Additionally, the FERC has determined that, while upstream development and

[14] Vol. 81, Federal Register, No. 136, Friday, July 15, 2016, pp 46157-46159.

[15] The USEPA suggested that the final EIS consider DOE's *Addendum to Environmental review Documents Concerning Exports of Natural Gas from the United States*, wherein the agency provides additional information to the public regarding the potential environmental impacts of unconventional natural gas production activities. The Addendum provides GHG emissions information from the upstream natural gas industry as a whole, but DOE recognized that lacking an understanding of where and when additional gas production will arise, the environmental

production of natural gas might be a "reasonably foreseeable" effect of a proposed action, the actual scope and extent of potential GHG emissions from upstream natural gas production is not reasonably foreseeable (see FERC 2015). The CEQ's final guidance on evaluating GHG impacts does not require NEPA analyses to include such unforeseeable effects (CEQ 2016).

Regarding downstream GHG emissions from overseas transport, regasification and combustion of exported LNG, Delfin LNG has an application pending before DOE to export LNG to non-free trade agreement nations. The necessary factors for a meaningful analysis, including the demand for LNG exported from this Project, the destination(s) of the exports, the transport routes, and the ultimate end uses of the LNG, are unknown and, as such, the GHG emissions from same are not reasonably foreseeable.[16]

1.5 Permits, Approvals, and Regulatory Requirements

As the lead agencies for administration of the DWPA, license application processing and issuance, and NEPA compliance, the USCG and MARAD are responsible for compliance with the provisions of numerous Federal and State environmental laws that require consultation with other agencies concerning specific environmental resources. Agency consultations and correspondence can be found in Appendix D. Examples of these include Section 7 of the Endangered Species Act (ESA), the Magnuson-Stevens Fishery Conservation and Management Act (MSA), and Section 106 of the National Historic Preservation Act (NHPA). Described below are the various legal requirements and consultation obligations; where applicable, Sections 3, 4, and 6 also discuss those requirements. Any enforceable conditions imposed as part of an approved license must be consistent with the appropriate and applicable regulations.

The Applicant would be required to obtain approvals related to and comply with all applicable and appropriate permits, guidelines, and approvals as provided for in the CZMA, the CWA, and the CAA for any impacts on coastal resources, wastewater discharges, or regulated air emissions to the environment, respectively. The Applicant must also provide the licensing agency with the information necessary to evaluate potential compliance with the applicable regulations and guidelines.

The USCG issued a request for informal consultation and technical assistance to NOAA Fisheries and the USFWS on January 8, 2016. In a letter dated August 20, 2016, the USFWS concurred with the determination that the proposed onshore activities are not likely to adversely affect Federally listed species and that no further ESA consultation would be necessary for this proposed Project. Most recent correspondence with NOAA Fisheries indicates that concurrence with the determination made in this final EIS that the proposed offshore activities are not likely to adversely affect Federally listed species is under review. The receipt of a NOAA Fisheries concurrence letter on the final EIS findings for Federally listed

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impacts resulting from production activity induced by LNG exports to non-FTA countries are not "reasonably foreseeable" within the meaning of the CEQ NEPA regulations (40 CFR § 1508.7). See DOE (2014, p. 2).

[16] The USEPA suggested that the final EIS consider the analysis prepared by the DOE's National Energy Technology Laboratory (NETL) in 2014 into the estimated "life cycle" of GHG emissions for exporting LNG from the U.S. In the life-cycle analysis, NETL identified two representative markets for U.S. exported LNG—Rotterdam, Netherlands, and Osaka, Japan—then compared the total GHGs that would be emitted to generate one megawatt hour (MWh) of electricity in each market, using: (1) LNG imported from the United States; (2) LNG imported from closer regional sources; (3) natural gas exported via pipeline from Russia; and (4) regional coal. In each scenario, NETL considered carbon dioxide (CO_2) and methane emissions from all stages of fuel production, from extraction to final combustion. NETL concluded that exporting U.S. LNG to produce power in Europe and Asia will not increase GHG emissions compared to regional coal power, and that potential differences in GHG emissions relating to the use of U.S. LNG, regional LNG, or Russian gas are largely limited to "transport distance" and are otherwise "indeterminate" due to uncertainty in the modeling data. Additionally, NETL concluded that no significant increase or decrease in net climate impact is anticipated from any of these scenarios (see NETL 2014, p. 18). Because NETL analyzed representative approaches for U.S. LNG exports, the general conclusions regarding GHG emissions from such exports are expected to apply to this Project.

species will be included as a condition of the ROD. All consultation correspondence to date is located in Appendix D of this final EIS.

Table 1.5-1 lists major Federal and State permits, approvals and consultation requirements required to construct and operate a natural gas deepwater port.

1.5.1 Provisions of the Endangered Species Act (ESA)

Section 7 of the ESA states that any project authorized, funded, or conducted by any Federal agency should not "… jeopardize the continued existence of any endangered species or threatened species or result in the destruction or adverse modification of habitat of such species which is determined … to be critical." The USCG and MARAD, or an applicant if designated as a non-Federal representative, are required to "informally" consult with the USFWS and NOAA Fisheries to determine whether any Federally listed or proposed endangered or threatened species or their designated critical habitats occur near the proposed Port facilities. If it is determined that these species or habitats might be affected by the proposed Project, the USCG and MARAD must begin "informal" consultation with the USFWS or NOAA Fisheries and prepare a Biological Assessment (BA) to identify the nature and extent of effects and recommend measures that would avoid or reduce potential effects to the species. The BA would be used for determining whether the effects would likely jeopardize any listed species or result in the destruction or adverse modification of designated critical habitat. After review of the BA, either NOAA Fisheries or the USFWS, or both, would issue a Biological Opinion (BO) on the potential for jeopardy. NOAA Fisheries and/or the USFWS may also issue an incidental take statement as an exception to the takings prohibitions in Section 7 of the ESA. The threatened and endangered species sections of this final EIS (Sections 3.2.3. 3.3.3, 4.2.3, and 4.3.3), as well as Section 2.0, serve as the BA. Agency consultations under Section 7 of the ESA were initiated on January 8, 2016. As noted above in Section 1.5, the USFWS concurred with the determination that the proposed activities are not likely to adversely affect Federally listed species and that no further ESA consultation would be necessary for this proposed Project in a letter dated August 20, 2016. However, most recent correspondence with NOAA Fisheries indicates that concurrence with the determination made in this final EIS that the proposed offshore activities are not likely to adversely affect Federally listed species is under review. The receipt of a NOAA Fisheries concurrence letter on the final EIS findings for Federally listed species will be included as a condition of the Record of Decision. Correspondence with the USFWS and NOAA Fisheries, with respect to the ESA, is presented in Appendix D, Agency Correspondence.

1.5.2 Provisions of Magnuson-Stevens Fishery Conservation and Management Act

The MSA, amended by the Sustainable Fisheries Act of 1996, establishes procedures designed to identify, conserve, and enhance essential fish habitat (EFH) for those species regulated under a Federal Fishery Management Plan (FMP). The MSA requires Federal agencies to consult with NOAA Fisheries on all actions or proposed actions authorized, funded, or undertaken by the agency that might adversely affect EFH. NOAA Fisheries recommends consolidated EFH consultations with interagency coordination procedures required by other statutes such as NEPA or the ESA (50 CFR 600.920(e)(1)) to reduce duplication and improve efficiency. The mandatory content of an EFH Assessment is detailed in 50 CFR 600.920(e)(3). Sections 3.2.4 and 4.2.4 of this final EIS describe EFH and potential project-related impacts. In a comment received by the USCG on the docket (USCG-2015-0472-0090) dated August 29, 2016, NOAA Fisheries concurred with the conclusion of the EFH Assessment that proposed Project implementation will not result in a substantial adverse effect to EFH or Federally managed fishery species. In addition, NOAA Fisheries has concluded that further coordination pursuant to requirements of the Magnuson-Stevens Fishery Conservation and Management Act is unnecessary for this project. Appendix E presents a detailed assessment of EFH in the ROI.

Table 1.5-1. Major Permits, Approvals, and Consultations for Natural Gas Deepwater Ports

Agency	Permit/Approval/Consultation	Timeline
U.S. Department of Homeland Security, U.S. Coast Guard (USCG)	• License application processing • Post-licensing design, construction, operations approval, and oversight • National Environmental Policy Act (NEPA) lead agency for preparation of a single Environmental Impact Statement (EIS) of the onshore and offshore deepwater port facilities (collectively, the Project) • Certification that navigational aids for the deepwater port meet the applicable requirements	• DEIS published – July 2016 • USCG DEIS public meetings held 9-10 August 2016 • FEIS projected 4th Qtr 2016 • MARAD Record of Decision projected 1st Qtr 2017
U.S. Department of Transportation (DOT), Maritime Administration (MARAD)	• The license issuing authority must determine that an applicant's financial and U.S. citizenship requirements have been met before a final license can be issued. MARAD, with the assistance of the USCG, issues a Record of Decision, which outlines the Secretary of Transportation's decision on a deepwater port license application and defines the legal scope of the final license document as defined by the provisions of the Deepwater Port Act.	• DEIS published – July 2016 • FEIS projected 4th Qtr 2016 • MARAD Record of Decision projected Q1 2017
Federal Energy Regulatory Commission (FERC)	• Authorization to reactivate, construct, operate and maintain onshore metering, pipeline and compression facilities pursuant to Section 7(c) of the National Gas Act (NGA) • Authorization to abandon pipeline under Section 7(b) of the NGA	• NGA, Sections 7(b) and 7(c) Authorization expected: projected 1st Qtr. 2017
DOT, Pipeline and Hazardous Materials Safety Administration (PHSMA)	• Establish and enforce deepwater port pipeline safety regulations • Consultation on LNG facility design	• No permit; Delfin LNG will comply with PHMSA safety regulations for natural gas pipeline construction & operation
U.S. Department of the Interior, Bureau of Offshore Energy Management (BOEM)	• Advise USCG and MARAD concerning the potential impacts of DWPA terminals on OCS lease blocks • Pipeline right-of-way application and coordination • Hazard surveys guidance and coordination • Archaeological coordination	• Delfin LNG to continue discussions with BOEM on OCS right-of-way application • BOEM Right-of-Way (ROW) application expected: 1st half 2017 • ROW expected late 2017 or early 2018 • USCG to continue NEPA consultation
U.S. Department of the Interior, Bureau of Safety and Environmental Enforcement (BSEE)	• Advise USCG and MARAD concerning the potential impacts of DWPA terminals on OCS lease blocks • Oil Pollution Act of 1990 liability adjustment	• No permit; consultation only • USCG to continue NEPA consultation

Table 1.5-1. Major Permits, Approvals, and Consultations for Natural Gas Deepwater Ports (continued)

Agency	Permit/Approval/Consultation	Timeline
U.S. Department of the Interior, U.S. Fish and Wildlife Service (USFWS)	• Section 7 ESA coordination • Fish and Wildlife Coordination Act consultation Migratory Bird Treaty Act coordination • Coastal Barrier Resources Act coordination	• No permit; consultation only • In a letter dated August 20, 2016, the USFWS concurred with the determination that the proposed onshore activities are not likely to adversely affect federally listed species and that no further ESA consultation would be necessary for this proposed Project.
U.S. Department of the Interior, Bureau of Indian Affairs (BIA)	• Tribal consultations and notifications	• No permit; USCG to continue NEPA consultation
U.S. Environmental Protection Agency (USEPA)	• Clean Water Act (CWA) National Pollutant Discharge Elimination System (NPDES) permit • CWA Section 404 permit and mitigation consultation • Title V Clean Air Act (CAA) permit • CAA New Source Review (NSR) • CAA Preconstruction permit • CAA General Conformity Determination • Marine Protection Research and Sanctuaries Act consultation	• Delfin LNG expects to submit final NPDES permit application to USEPA Region 6 in 1st Qtr 2017 • NPDES permit expected: early/mid 2017 • Delfin LNG to submit final NSR and Title V Operating Permit to USEPA Region 6 for processing in 2nd half of 2016. • NSR and Title V Operating Permit expected: 1st Qtr. 2017 • No permit. Preliminary consultation meeting held March 17, 2015 • USCG to continue consulting with USEPA Region 6 on NEPA and MPRSA.
U.S. Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service (NOAA Fisheries)	• Section 7 ESA coordination • Essential Fish Habitat (EFH) coordination under MSA • Marine Mammal Protection Act coordination • National Marine Sanctuaries Act (NMSA) Section 304(d) consultation	• Delfin LNG to engage NOAA (Silver Spring, MD) regarding need for possible IHA for offshore pile driving: 1st Qtr 2017 • USCG to continue NEPA consultation
U.S. Army Corps of Engineers (USACE)	• Section 404 CWA permit • Rivers and Harbors Act Section 10 permit	• Section 10/404 permit expected: 4th Qtr 2016
U.S. Department of Defense	• Consultation (review of license application adequacy and views on effects to departmental programs)	• No permit; consultation only.

Table 1.5-1. Major Permits, Approvals, and Consultations for Natural Gas Deepwater Ports (continued)

Agency	Permit/Approval/Consultation	Timeline
U.S. Department of State, Bureau of Oceans and International Environmental and Scientific Affairs	• Consultation (review of license application adequacy and views on effects to departmental programs)	• No permit; consultation only.
Advisory Council on Historic Preservation	• National Historic Preservation Act (NHPA) Section 106 consultation	• No permit; consultation only
Office of the Governor, Louisiana	• Consent to issue license	• DWPA approval expected: early 2017
Louisiana State Historic Preservation Office (State Historic Preservation Office [SHPO])	• Section 106 NHPA coordination • Approval of Unanticipated Discoveries Plan	• No permit; consultation only • Received comments from Louisiana SHPO on September 27, 2016 that no additional cultural resource surveys were needed and that Delfin LNG's proposed Avoidance Plan was approved
Louisiana Department of Environmental Quality (LDEQ) Water Quality Division	• Section 401 Water Quality Certification • Louisiana Pollutant Discharge Elimination System Permit • Construction stormwater discharge permit • Approval of Stormwater Pollution Prevention Plan (SWPP)	• Hydrostatic Test Water discharge Notice of Intent for coverage under General Permit expected: 2017 • Construction stormwater discharge Notice of Intent to be covered under General Permit, expected: 2017 • LDEQ approval of Stormwater Pollution Prevention Plan (SWPPP) expected: 2017 • CWA Section 401 Certification expected: Concurrent with issuance of LDNR OCM Coastal Use Permit for Section 10/404 application
LDEQ Air Quality Division	• Clean Air Act (CAA) • New Source Review (NSR) • Prevention of Significant Deterioration Permit • Title V operating permit for emissions sources within state boundaries (Delfin onshore facilities only)	• CAA Permit expected: 2nd half 2016.

Table 1.5-1. Major Permits, Approvals, and Consultations for Natural Gas Deepwater Ports (continued)

Agency	Permit/Approval/Consultation	Timeline
Louisiana Department of Natural Resources, Office of Coastal Management	• CZMA Consistency Certification • Coastal Use Permit (CUP) application	• CZMA consistency determination received: August 3, 2016 • CUP expected: early/mid 2017
Louisiana Department of Wildlife and Fisheries	• Consultation (protected species)	• No permit; consultation only
Texas Historical Commission (SHPO)	• Section 106 NHPA coordination	• No permit; consultation only
Texas General Land Office	• CZMA consistency certification	• CZMA constancy determination received August 7, 2015
Native American Tribes	• NHPA Section 106 consultation • Archeological Resources Protection Act consultation • Native American Graves Protection and Repatriation Act consultation	• No permit; consultation only
Cameron Parish Coastal Zone Program	• CZMA consistency approval	• Cameron Parish Police Jury Coastal Zone Management Plan consistency approval received: June 29, 2015
Cameron Parish Policy Jury	• Local Building Permits • Flood Plain Development Authorization permit	• Local Building Permits expected: 2018 (prior to construction) • Flood plain Development Authorization Permit expected: 2018 (prior to construction)
Cameron Parish Waterworks District 1, Cameron	• Public Water System consultation	• No permit; consultation only

1.5.3 Provisions of the Marine Mammal Protection Act

The MMPA prohibits the "take" of marine mammals, with certain exceptions, in waters under U.S. jurisdiction and by U.S. citizens on the high seas. Under Section 3 of the MMPA, "take" is defined as "harass, capture, hunt, kill, or attempt to harass, capture, hunt, or kill any marine mammal." "Harassment" is defined as "any act of pursuit, torment, or annoyance that has the potential to injure marine mammal stock in the wild; or has the potential to disturb marine mammal stock in the wild by disrupting behavioral patterns, including migration, breathing, nursing, breeding, feeding, or sheltering." In cases where U.S. citizens are engaged in activities, other than fishing, that result in "unavoidable" incidental take of marine mammals, the Secretary of Commerce can issue a "small take authorization." The authorization can be issued after notice and opportunity for public comment if the Secretary of Commerce finds negligible impacts. The MMPA requires consultation with NOAA Fisheries if impacts on marine mammals are unavoidable. The Applicant could be required to obtain a small take authorization, as deemed necessary by NOAA Fisheries upon conclusion of agency consultation.

1.5.4 Provisions of the National Historic Preservation Act

Section 106 of the NHPA requires the USCG and MARAD to consider the effects of its undertakings on properties listed on or eligible for listing on the National Register of Historic Places (NRHP), including prehistoric or historic sites, districts, buildings, structures, objects, or properties of traditional religious or cultural importance, and to allow the Advisory Council on Historic Preservation (ACHP) to comment on the undertaking. Consultation with the State Historic Preservation Office (SHPO) would take place in the event of a potential adverse impact on historic properties as a result of the proposed Project. The USCG and MARAD have sent out initial consultation letters to both the Louisiana and Texas SHPOs.

The cultural resources sections of this final EIS discuss the Section 106 review.

In letters dated January 4, 2016, the USCG initiated consultation with the Louisiana and Texas SHPOs. The letters briefly described the proposed Project and included a map showing the proposed Project location. The letter explained that the USCG and MARAD are preparing an EIS as part of the environmental review of the Delfin LNG deepwater port license application and asked if the SHPOs had any concerns regarding potential effects of the Project construction or operation on cultural resources that may be listed in or eligible for listing on the NRHP.

On September 11, 2015, the Choctaw Nation of Oklahoma requested Consulting Party status for the proposed Project. The tribe noted a particular interest in ground-disturbing activity onshore and requested a copy of the EIS. On November 7, 2016, the Choctaw Nation Historic Preservation Department concurred with the Onshore Unanticipated Discoveries Plan, as provided in response to their Consulting Party status request. USCG consulted the following Native American Tribes by letters dated January 4, 2016: Alabama Coushatta Tribe of Texas, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, Mississippi Band of Choctaw Indians, and the Tunica-Biloxi Tribe of Louisiana. On January 12, 2016, the Quapaw Tribe of Oklahoma declined the opportunity to comment on the proposed Project as it would be located outside of the current area of interest for the tribe. On February 17, 2016, the Jena Band of Choctaw Indians provided concurrence with a determination of No Effect to Historic Properties. On February 22, 2016, the Choctaw Nation of Oklahoma requested GPS coordinates/GIS shapefiles and additional information on cultural resource investigations.

All consultation correspondence to date is located in Appendix D of this final EIS.

1.5.5 Marine Protection, Research, and Sanctuaries Act

Under Section 101 of the MPRSA, 33 U.S.C. Part 1401, no person may transport material from the United States for the purpose of dumping it in ocean waters in the absence of a permit issued by USEPA pursuant to Section 102 of the Act. "Dumping" does not include "construction of any fixed structure or artificial island nor the intentional placement of any device in ocean waters, or on or in the submerged land beneath such waters, for a purpose other than disposal, when such construction or such placement is otherwise regulated by federal or state law."

1.5.6 Coastal Zone Management Act

The CZMA calls for the "effective management, beneficial use, protection, and development" of the nation's coastal zone and promotes active State involvement in achieving those goals. To reach those goals, the CZMA requires participating states to develop management programs that demonstrate how these states would meet their obligations and responsibilities in managing their coastal areas. The agencies responsible for administering the CZMA in the designated adjacent coastal states are the Louisiana Department of Natural Resources (LDNR) Office of Coastal Management and the Texas General Land Office (GLO). The Applicant must prepare two consistency certifications, finding that its proposed activities would be fully consistent with the enforceable policies of both states' coastal zone management programs and submit it to both states for review.

Concurrent with its DWPA application, Delfin LNG prepared a joint Louisiana Coastal Use Permit (CUP) /USACE application that detailed both the proposed DOF and proposed Delfin Port. This joint application was also submitted to the LDNR Office of Coastal Management Consistency Section for review and approval. The CUP, USACE permit, and the consistency determination must be issued before the proposed Project can commence construction. On August 3, 2016, the LDNR Office of Coastal Management provided a determination that the proposed Project is consistent with the Louisiana Coastal Resources Program as required by Section 307 of the CZMA. Delfin LNG has also requested a CMP consistency determination from the Texas GLO. On August 7, 2015, the Texas GLO Texas Coastal Management Program provided a determination that there are no significant unresolved consistency issues with respect to the proposed Project. Correspondence with these state agencies, with respect to the CZMA, is provided in Appendix D, Agency Correspondence. Please see Section 7 of this final EIS for details relating to coastal zone consistency.

1.5.7 Clean Water Act

The Federal CWA, as amended in 1977, establishes the basic structure for regulating discharges of pollutants into the waters of the United States. The objective of the CWA is to restore and maintain the chemical, physical, and biological integrity of the nation's waters (33 U.S.C. 12151) and gives the USEPA the authority to implement pollution control programs such as setting wastewater standards for industry. The CWA also sets water quality standard requirements for all contaminants in surface waters and makes it unlawful for any person to discharge any pollutant from a point source into navigable waters, unless a permit is obtained under its provisions. Three sections of the CWA are applicable to the proposed Project:

- Section 401, which requires Federal agencies to obtain certification from the State, territory, or Indian tribes before issuing permits that would result in increased pollutant loads to a waterbody. Section 401 certification is issued only if such increased loads would not cause or contribute to exceedances of water quality standards. Section 401 water quality criteria are developed by State agencies for receiving waters based on their beneficial uses;
- Section 402, which requires that developers obtain an NPDES Permit for point source discharges into a surface waterbody; and
- Section 404, which regulates the placement of dredge or fill materials into waters of the United States.

For the proposed Project, surface water quality standards for State waters are administered by the Louisiana Department of Environmental Quality (LDEQ) Water Quality Division. The proposed Project would require an application to the LDEQ for a Section 401 Permit. Louisiana would issue the Section 401 Water Quality Certification in conjunction with the issuance of the above-mentioned permits and approvals.

The primary mechanism in the CWA regulating the discharge of pollutants is the NPDES, which is administered by the USEPA. Under the NPDES program, a permit is required from USEPA or an authorized State for the discharge of any pollutant from a point source into the waters of the United States (Section 402; 33 U.S.C. 1342). An NPDES permit for certain stormwater discharges is also required. In the case of discharges to the territorial sea or beyond, permits are also subject to the ocean discharge criteria developed under Section 403 of the CWA (33 U.S.C. 1343). Permits for discharges into the territorial sea or internal waters may be issued by states following approval of their permit program by USEPA; in the absence of an approved State permit program, and for discharges beyond the territorial sea, USEPA is the permit-issuing authority.

The Section 404 permit program is administered by the USACE, but is subject to review by the USEPA and other resource agencies such as the USFWS, NOAA Fisheries, and applicable State agencies. The USEPA regulates and permits discharges to Louisiana and Federal waters through the NPDES program under the CWA. All consultation correspondence to date is located in Appendix D of this final EIS.

1.5.8 Clean Air Act

The United States Congress passed the CAA in 1963, the CAA Amendment in 1966, the CAA Extension in 1970, and CAA Amendments in 1977 and 1990. The CAA requires USEPA to set limits on how much of a pollutant can be in the ambient air anywhere in the United States. These limits are known as the National Ambient Air Quality Standards (NAAQS). The law allows individual states to have ambient air quality standards stronger than the NAAQS, but states are not allowed to have weaker standards than the NAAQS. The main or "criteria" air pollutants with NAAQS established by the CAA are ozone, sulfur dioxide (SO_2), particulate matter (PM), lead, nitrogen oxides (NO_x), and carbon monoxide (CO). The CAA includes specific limits, timelines, and procedures to reduce these criteria pollutants. The CAA also regulates what are called “hazardous air pollutants” (HAPs). SO_2 and NO_x, which contribute to acid rain, are regulated by the CAA under a comprehensive permit program for electric generating facilities. The act protects stratospheric ozone by restricting the use of chlorofluorocarbons (CFCs) and limits ambient ozone by regulating the emissions of volatile organic compounds (VOCs) and NO_x.

Under the CAA, states have to develop state implementation plans (SIPs) that explain how each State will meet the NAAQS established under the CAA. A SIP is a collection of the regulations a State will use to clean up areas that are not meeting the NAAQS and maintain those areas in compliance with the NAAQS. USEPA must approve each SIP, and if a SIP is not acceptable, USEPA can take over enforcement of the CAA in that State.

Delfin LNG intends to submit its final NSR and Title V Operating Permit application to USEPA Region 6 for processing the in 2017 and expects to receive these permits later in calendar year 2017. All consultation correspondence to date is located in Appendix D of this final EIS.

1.5.8.1 New Source Review/Prevention of Significant Deterioration

One of the key programs designed to achieve compliance with the NAAQS is the New Source Review (NSR) program, a preconstruction review process for new and modified stationary sources. The NSR program has two component parts: the Prevention of Significant Deterioration (PSD) program for attainment or “clean” areas, which requires new or modified sources to install state-of-the-art pollution controls to ensure that the ambient air quality will not degrade. The non-attainment area NSR program is designed to ensure that any new industrial growth in an area not meeting the NAAQS will comply with stringent emission limitations (by requiring the most protective pollution controls and emission offsets), with the goal of improving air quality overall to meet the NAAQS. The NSR program requires companies to obtain a permit for new construction or major modifications that substantially increase a facility's emissions of a criteria pollutant.

1.5.8.2 Title V Permits

State environmental agencies issue air permits to large stationary sources of pollution, including all sources subject to NSR permitting. The permitting process provides an operating permit for sources after they have completed construction or modification to document all emission limits, monitoring, recordkeeping and reporting requirements for ongoing operation of the new or modified facility. The information contained in this permit and all required records are available to the permitted facility, other agencies, and the public. These permits are known as "Title V" permits because they are required by Title V of the 1990 CAA. The Title V permit is meant to contain all the requirements for the permitted source and includes semi-annual and annual certification of compliance with the permit, all of which is public information.

1.5.8.3 General Conformity

Section 176(c)(1) of the CAA established requirements to ensure that Federal actions or actions approved by Federal agencies do not adversely affect a State's ability to achieve and maintain attainment with the NAAQS for projects located in an area not in attainment with the NAAQS for one or more criteria pollutants. No emissions from construction or operation of the proposed Project would occur in any designated nonattainment area. Therefore, no further evaluation of potential Project emissions with respect to General Conformity is required.

1.5.9 Migratory Bird Treaty Act

Migratory birds are protected under the Federal Migratory Bird Treaty Act of 1918 (MBTA; 16 U.S.C. 703-712; Ch. 128; July 13, 1918; 40 Stat. 755) and was enacted as a prohibition on the killing of migratory birds. Migratory bird species listed under this act occur throughout the general Project vicinity, and indeed are ubiquitous worldwide. Additionally, Executive Order 13186 (66 Federal Register 3853) directs Federal agencies to identify where unintentional take is likely to have a measurable negative effect to migratory bird populations and to avoid or minimize adverse impacts on migratory birds through enhanced collaboration with the USFWS. While the act does not explicitly contain specific compliance measures to address potential impacts on migratory birds, developers are encouraged to evaluate existing avian resources within a proposed ROI and take reasonable measures to prevent avian impacts. Executive Order 13186 also states that emphasis should be placed on species of concern, priority habitats, and key risk factors, and that particular focus should be given to addressing population-level impacts.

1.5.10 Bald and Golden Eagle Protection Act

The Bald and Golden Eagle Protection Act (BGEPA) makes it unlawful to take, possess, sell, purchase, barter, offer to sell, purchase or barter, transport, export or import, at any time or any manner, any bald or golden eagle, alive or dead, or any part, nest, or egg thereof without a permit. Since delisting of the Bald Eagle under ESA in 2007, bald eagles are now protected solely by the BGEPA along with MBTA. The proposed Project is not expected to have any effect to bald or golden eagles because of the distance from shore, and because the proposed DOF would be designed to avoid impacts.

1.5.11 Oil Pollution Act

The Oil Pollution Act of 1990 (OPA) streamlined and strengthened the USEPA's ability to prevent and respond to catastrophic oil spills. A trust fund financed by a tax on oil is available to clean up spills when the responsible party is incapable or unwilling to do so. The OPA requires oil storage facilities and vessels to submit to the Federal government plans detailing how they will respond to large discharges. The USEPA has published regulations for aboveground storage facilities; the USCG has done so for oil tankers. The OPA also requires the development of Area Contingency Plans to prepare and plan for oil spill response on a regional scale.

1.5.12 Archeological Resources Protection Act

The Archeological Resources Protection Act (ARPA) established requirements to protect archaeological resources and sites on public lands and Indian lands and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals. The Act (16 U.S.C. 470aa-470mm) established civil and criminal penalties for the destruction or alteration of cultural resources. The U.S. DOI has issued regulations under the ARPA, available at 43 CFR 7, establishing definitions, standards, and procedures to be followed by all Federal land managers in providing protection for archaeological resources located on public lands and Indian lands of the United States. In addition, the National Park Service (NPS) has issued regulations under the ARPA for the curation of Federally owned and administered collections; these regulations are available at 36 CFR 79.

1.5.13 Native American Graves Protection and Repatriation Act

The Native American Graves Protection and Repatriation Act of 1990 (NAGPRA) and the regulations (43 CFR Part 10) that allow for its implementation address the rights of lineal descendants, Indian tribes, and Native Hawaiian organizations (parties with standing) to Native American human remains, funerary objects, sacred objects, and objects of cultural patrimony (cultural items). The statute requires Federal agencies and museums to provide information about Native American cultural items to parties with standing and, upon presentation of a valid claim, ensure the item(s) undergo disposition or repatriation. NAGPRA requires that the Bureau of Reclamation complete a number of reports and submit them to tribes and the DOI through the National NAGPRA Program.

2.0 DESCRIPTION OF THE PROPOSED ACTION AND ALTERNATIVES

2.1 Introduction

The following sections present a detailed description of the design, construction, operation, and eventual decommissioning of the proposed Project (Section 2.2); and an analysis of deepwater port alternatives, including the No Action Alternative (Section 2.3.11).

2.2 Detailed Description of the Proposed Action

The general location of the proposed Port Delfin LNG Project (Project) is depicted in Figure 1-1. The proposed offshore Port (Port) would be located in Federal waters of the West Cameron, West Addition Protraction Area (Gulf of Mexico) in the Bureau of Offshore Energy Management (BOEM) defined Outer Continental Shelf (OCS) West Cameron blocks (WC) 319, 327, 328, 334, and 335, approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana. The proposed Port would be sited in water depths ranging from 64 to 72 feet (ft) and would consist of four tower yoke mooring system (TYMS) to which four floating liquefied natural gas vessels (FLNGVs) would be moored, four new pipeline laterals, and two existing offshore natural gas pipelines. In addition to Louisiana, a portion of the existing pipeline system is within 15 nautical miles of Texas, making it an adjacent coastal state as defined by the Deepwater Port Act (DWPA; 33 U.S. Code [U.S.C.] Section 1502 (1)).

The proposed Project would originate onshore in Cameron Parish, Louisiana where Delfin LNG LLC (Delfin LNG) proposes to construct a compressor station, meter station, gas supply header, and other ancillary facilities. Delfin LNG would transport gas from the existing natural gas infrastructure located at Transcontinental Gas Pipe Line Company, LLC (Transco) Station 44 to its new 120,000 horsepower (hp) compressor station and into an approximately 1.1-mile onshore segment of the existing U-T Offshore System (UTOS) 42-inch-diameter pipeline. From shore, the gas would continue to be transported through the existing UTOS pipeline to the WC 167 offshore manifold platform, located approximately 24.7 nautical miles from shore. Here, Delfin LNG would construct a new, 42-inch-diameter subsea bypass pipeline that would connect the UTOS pipeline to the High Island Offshore System (HIOS) pipeline, thereby bypassing the WC 167 offshore manifold platform. The gas would then be transported through the existing 42-inch-diameter HIOS pipeline to the proposed Port location. The farthest of the four FLNGVs would be approximately 18.6 nautical miles from the WC 167 offshore manifold platform. The natural gas would then be transported through one of the four newly constructed, 30-inch-diameter subsea laterals for a distance of approximately 6,400 ft. Natural gas would flow from the pipeline lateral through a riser attached to the TYMS where it would be transferred to the FLNGV, liquefied, and transferred by side-by-side configuration to LNG carriers (LNGCs) for export.

The FLNGVs would be designed to process 500 million standard cubic feet per day (MMscf/d) of input feed gas. When all four FLNGVs are taken into account, this would equate to 2.0 billion standard cubic feet per day (Bscf/d) for the entire proposed Project. Assuming an estimated production unit availability of 92 percent and when the consumption of feed gas is taken into account, each FLNGV would produce approximately 3.0 million metric tonnes per annum (MMtpa), or a total of 12.0 MMtpa for the entire Project, of LNG for export. Under optimized design, each FLNGV would require approximately 575 MMscf/d of feed gas to produce 3.3 MMtpa of LNG for export, or 13.3 MMtpa for the entire Project, which is equivalent to 657.5 billion standard cubic feet per year (Bscf/yr) of LNG for export. This is the amount Delfin LNG was authorized to export to free-trade agreement countries by the U.S. Department of Energy, Office of Fossil Energy (DOE/FE) on February 20, 2014.

2.2.1 Lease Blocks and Overall Site Plan

The proposed Project would originate at the proposed Delfin Onshore Facility (DOF) in Cameron Parish, Louisiana, and would use two existing and underutilized 42-inch outside-diameter pipelines to be interconnected by a new bypass to be added at WC 167 and new offshore laterals to connect the existing pipelines to the FLNGVs in the general vicinity of WC 327. All proposed Project facilities would be located in the BOEM-defined WC. The offshore portion of the proposed Project would be located in the Gulf of Mexico, south of the area of coastline between the Calcasieu River and Sabine Pass, offshore of southwest Louisiana. The existing HIOS pipeline segment planned for use by Delfin LNG transects Lease Blocks WC 314, 318, 319, 327, and 335. Proposed Delfin LNG moorings #1, #2, #3, and #4 would be located in WC 319, 327, 328, and 334 blocks, respectively. Figure 1-1 shows the general location of the proposed Project. A more detailed description of the proposed moorings, pipeline laterals, bypass and ancillary facilities is provided in the sections below. The Region of Influence (ROI) for impacts on resources described in this final Environmental Impact Statement (EIS) includes the area within and directly adjacent to the proposed Port location and proposed bypass location that could be affected by construction, operation, and decommissioning of the proposed Project. A detailed summary of lease blocks where the proposed Project facilities would occur is provided in Table 2.2-1 and depicted in Figure 1-1.

Table 2.2-1. Lease Block Information

Project Facility	OCS Lease Blocks a/
UTOS Pipeline	19, 46, 55, 56, 81, 92, 93, 116, 115, 130, 151, 150, 167
WC 167 Bypass	167
HIOS Pipeline b/	167, 186, 189, 208, 302, 303, 314, 318, 319, 327, 335
TYMS 1 b/, c/	319
TYMS 1 Pipeline Lateral	319
Service Vessel Mooring 1	319
TYMS 2 b/, c/	327
TYMS 2 Pipeline Lateral	327
Service Vessel Mooring 2	327
TYMS 3 b/, c/	328
TYMS 3 Pipeline Lateral	327, 328
Service Vessel Mooring 3	328
TYMS 4 b/, c/	327, 328, 334, 335
TYMS 4 Pipeline Lateral	327, 328
Service Vessel Mooring 4	334

Notes:

a/ HIOS pipeline extends south through High Island Area, East Addition to Highland Area, East Addition, South Extension Block A264, as shown on Figure 1-1; however, WC Block 335 is the last block within the proposed Project area because the remaining section of the HIOS pipeline would not result in any impacts.

b/ Blocks identified include area for TYMS Safety Zone

c/ FLNGVs would be moored at the TYMS.

2.2.2 Existing Pipeline Infrastructure

Extending from the edge of the Transco Station 44 property, Delfin LNG would utilize existing infrastrpg ucture to transport natural gas to the FLNGVs. Onshore and offshore portions of the existing UTOS pipeline would transport gas to the vicinity of the WC 167 offshore manifold platform, where a 700-ft bypass would be constructed to transfer gas into the existing HIOS pipeline before reaching the pipeline laterals and ultimately the FLNGVs.

2.2.2.1 Former UTOS Pipeline

The UTOS pipeline is an existing 42-inch-diameter pipeline that extends from Cameron Parish, Louisiana, to the existing WC 167 offshore manifold platform, located approximately 24.7 nautical miles from shore. When the pipeline was installed in 1978, the pipeline was trenched to a depth of 3 ft below the seafloor. Concrete weight coatings were installed to ensure negative buoyancy of the pipeline. Corrosion protection and sacrificial bracelet anodes were also installed on the pipeline. The UTOS pipeline was designed with a maximum allowable operating pressure (MAOP) of 1,250 pounds per square inch gauge (psig).

The UTOS pipeline is currently owned by Delfin Offshore Pipeline LLC. It was formerly owned by Enbridge Offshore Pipelines LLC who in 2011 filed a Section 7(b) application with the Federal Energy Regulatory Commission (FERC) to abandon the pipeline (FERC Docket No. CP11-526-000). FERC approved the abandonment in April 2011, subject to the condition that an implementation plan be filed within 3 years, outlining the final disposition of the facilities. The UTOS line was then purged of gas, cleaned, and filled with nitrogen. In September 2014, FERC approved the jurisdictional disposition finding and no additional environmental review was required.

Delfin LNG contracted Universal Pegasus International (UPI) to conduct a due diligence analysis on the UTOS pipeline. The analysis included review of the following:

- As-built drawings;
- Original hydrostatic testing results;
- Operations and maintenance data including maintenance logs, annual reports, depth of cover surveys, and inspection reports;
- Procedures used to prepare the pipeline for suspension of service; and
- On-site inspection of the Transco Station 44 facility.

The analysis conducted by UPI found that the pipeline was constructed and maintained in accordance with applicable regulations and industry standards. Similarly, when prepared for the suspension of service, the procedures used to idle the pipeline with nitrogen followed applicable regulations and industry standards. Delfin LNG did not conduct hydrostatic testing on the UTOS pipeline after acquisition, nor was it done at any time after it was abandoned. Delfin LNG intends to perform inspection and testing, including hydrostatic and leak testing, representative surveying for depth of coverage, and inspection of concrete coating, to ensure integrity of the UTOS pipeline prior to commencing operations of the proposed Project. However, based on UPI's preliminary testing and reported findings, there are no data to suggest that the UTOS pipeline is in a condition that it could not safely and reliably transport natural gas.

2.2.2.2 Existing HIOS Pipeline

The HIOS pipeline is an existing 42-inch-diameter subsea pipeline extending from the WC 167 offshore manifold platform to an existing platform located at High Island Block A264, approximately 57.4 nautical miles distance. The distance between WC 167 and the most distant pipeline lateral would be 18.6 nautical miles. The pipeline was designed to operate with a MAOP of 1,440 psig. When the HIOS pipeline was placed into service in 1978, the pipeline was installed at a depth to ensure 3 ft of cover between the seafloor and the top of the pipe. Similar to the UTOS pipeline, concrete weight coatings, corrosion protection, and sacrificial bracelet anodes were installed on the pipeline during construction.

UPI conducted a due diligence review of the HIOS pipeline utilizing similar criteria to those used for the UTOS pipeline. Similar to the UTOS pipeline, UPI found that the HIOS pipeline was constructed and maintained in accordance with applicable regulations and industry standards. Though not a result of negligence during operation, the HIOS pipeline suffered damage in 2008 as a result of a vessel dragging its anchor during Hurricane Ike. In order to repair the damage, a 200-ft section of pipe was cut and replaced. The depth of cover in the vicinity of the damaged section was 5 to 6 ft. Interior inspection of the damaged section of pipe found the interior wall to be in excellent condition.

Delfin LNG and HIOS LLC entered into a Pipeline Services Agreement in 2015 providing Delfin LNG with the exclusive right to utilize the HIOS pipeline as part of its proposed Project. The section of the HIOS pipeline that Delfin LNG would utilize is under FERC jurisdiction; therefore, HIOS LLC has filed a Section 7(b) application with the FERC to abandon existing services to allow for the new use of the pipeline by Delfin LNG (see Docket No. CP16-20-000).

2.2.3 WC 167 Offshore Manifold Platform Bypass

The existing WC 167 offshore manifold platform is located northeast of the proposed Port and is an eight-pile platform owned by HIOS LLC that currently has seven gas pipelines connected to it. Due to the congestion and potential for additional compression that could be required, Delfin LNG proposed to bypass the WC 167 offshore manifold platform with a new, approximately 700-ft, 42-inch-diameter pipeline that would connect the existing UTOS and HIOS pipelines. The proposed bypass would be trenched with the top of the pipeline at least 3 ft below the mud line. The proposed bypass would be installed with concrete weight coatings, corrosion protection, and sacrificial bracelet anodes.

2.2.4 Pipeline Laterals

In order to transport gas from the existing HIOS pipeline to the TYMS and ultimately to the FLNGVs, Delfin LNG would need to construct four new pipeline laterals. The pipeline laterals would be constructed starting 16.0 nautical miles from the WC 167 offshore manifold platform to a distance of 18.6 nautical miles. Each of the four laterals would be 30 inches in diameter and approximately 6,400 ft, individually, in length. The MAOP for each of the pipeline laterals would be 1,250 psig. Each of the four proposed subsea pipeline laterals would be trenched such that the top of the pipe was at least 3 ft below the seafloor. The pipeline laterals would all be installed with concrete weight coating, corrosion protection, and sacrificial bracelet anodes.

2.2.5 Mooring Systems

The proposed Port would require two mooring systems during operation. The FLNGVs would be moored to the TYMS while the LNGCs would moor to the FLNGVs using side-by-side mooring. Each of these mooring systems is described in further detail below.

2.2.5.1 FLNGV Mooring System

The TYMS is a single-point mooring that would allow the FLNGVs (and the LNGCs moored to the FLNGVs) to freely and fully weathervane during operation of the proposed Port. The TYMS would be designed to allow the FLNGV to disconnect from the TYMS and sail away from the proposed Port should a hurricane or other major storm event warrant its departure. However, the mooring system, without a moored FLNGV, would be designed to safely withstand loads imposed on the system from Gulf of Mexico hurricane forces up to a 1,000-year storm return period.

Delfin LNG proposed to construct four TYMSs, one for each FLNGV. The TYMS would consist of a pile jacket structure that would require the installation of four driven piles (78 inches in diameter by 300 ft long). Detailed design would determine if additional piles are required. The anticipated benthic disturbance would be an area of 25 meters (m) by 25 m. The piles would be cylindrical steel piles installed with a steam or hydraulic hammer. The jacket structure would be mounted on the piles and connected to the manifold deck module and the turnable deck module, with an attached swivel stack. Figures 2.2-1 and 2.2-2 show a typical drawing and visual representation of the TYMS, respectively.

The pipeline laterals would connect to the TYMS via a riser that would transport gas from the pipeline lateral to the TYMS manifold deck. The riser would be constructed of rigid steel pipe and would be designed to absorb and dissipate flexural and axial bending. The pipe would be clamped to one of the TYMSs jacket legs. Incoming gas would flow through the emergency shutdown and subsea isolation valve and directed to the inlet separator. From here, the gas would flow from the TYMS to the FLNGVs for liquefaction.

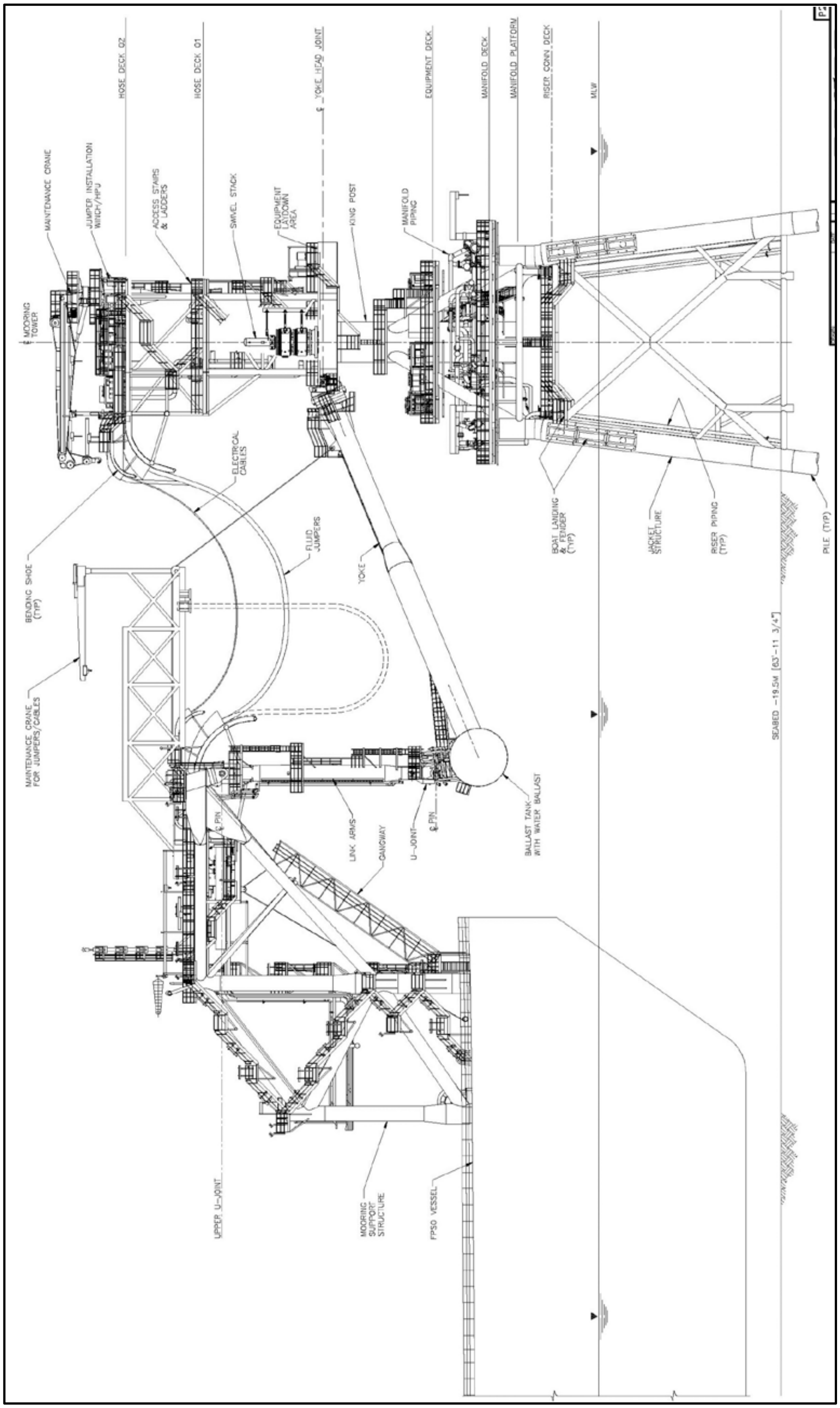


Figure 2.2-1. General Arrangement of the Tower Yoke Mooring System

Figure 2.2-2. Floating Liquefied Natural Gas Vessel on a Tower Yoke Mooring System

2.2.5.2 Offloading Mooring

Each FLNGV would contain an offloading mooring system that would allow the LNGCs to safely moor, in a side-by-side manner, to the FLNGV during the transfer of LNG (Figure 2.2-3). The offloading mooring system would be designed to accommodate LNGCs with nominal cargo capacities ranging from 125,000 m^3 and 177,000 m^3. The offloading arms or cryogenic hoses would be designed to accommodate all relative motions between the LNGC and FLNGV during cargo transfer. This method is an existing, proven technology within the industry.

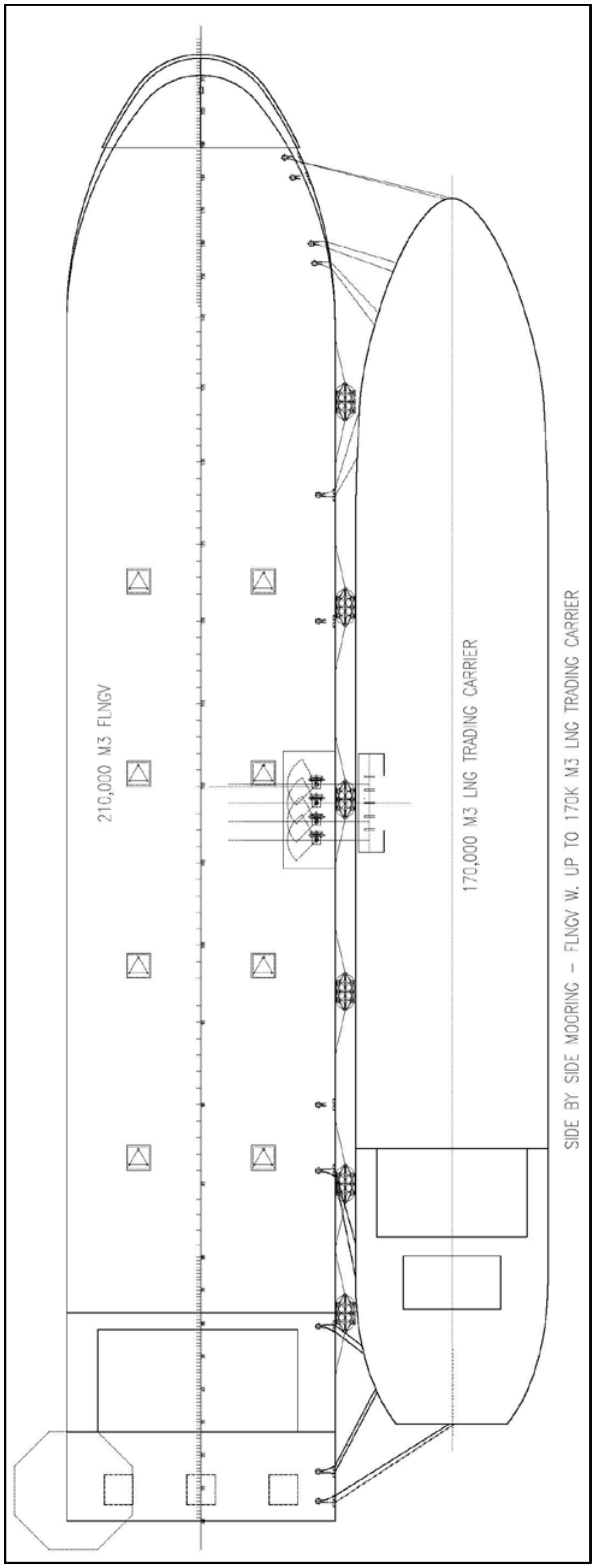


Figure 2.2-3. Side-by-Side Mooring Plan, 3.0 MMtpa FLNGV New-Build Hull with LNGC

2.2.5.3 Service Vessel Mooring

Anchoring points for service vessels would be installed in the vicinity of each TYMS. The service vessels could include tugboats, supply vessels, and crew boats. The purpose of the anchoring points would be to allow the service vessels to safely anchor and shut down their engines while awaiting the next assignment. The service vessel moorings would be lighted to provide navigation reference points, though are not proposed by Delfin LNG as aids to navigation. The approximate locations for the service vessel moorings are shown on Figure 1-1.

2.2.6 Floating LNG Vessels

The FLNGVs would be custom-designed for the proposed Project and flagged by the owner of the FLNGV. They would have a design life of 20 years without the need for dry-docking. At the conclusion of each FLNGV's 20-year service, inspections and resulting repair, reconditioning, or life extension works could keep each FLNGV in service for an additional 10 to 20 years. The hull and various vessel safety systems would be classified by an International Association of Classification Societies member. The FLNGV would be designed in accordance with the classification society and supplemented by additional U.S. Coast Guard (USCG) and regulatory requirements, and would be issued a USCG Certificate of Compliance for Foreign Flag LNG vessels operating in United States (U.S.) waters. The FLNGVs would be self-propelled and able to disconnect from the TYMS and exit the proposed Port in advance of extreme weather conditions or as needed. The FLNGVs and associated TYMSs would be positioned approximately two nautical miles from each other (see Figure 2.2-4). Each of the FLNGVs would contain accommodations and hotel services for 100 personnel on board and a helipad.

The FLNGVs would be designed to deliver LNG to the LNGCs via ship-to-ship transfer. The FLNGV would be able to accommodate LNGCs ranging in size from 125,000 cubic meters (m^3) to 177,000 m^3. Each FLNGV would be capable of processing 500 MMscf/d of input feed gas and would produce approximately 3.0 MMtpa via the three liquefaction trains on the topsides of the FLNGV. The approximate dimensions and capacities of the FLNGVs would be as follows:

- Length overall: 1,167.26 ft (355.78 m)
- Length waterline: 1,150.52 ft (350.68 m)
- Breadth: 213.25 ft (64.99 m)
- Depth: 104.99 ft (32.00 m)
- Design draft: 35.27 ft (10.75 m)
- Cargo tank capacity: 7,416,080 ft^3 (210,000 m^3)
- Ballast water tanks: 4,502,232 ft^3 (127,489 m^3)
- Marine diesel oil tanks: 79,846.5 ft^3 (2,261 m^3)
- Lubrication oil tanks: 706.3 ft^3(20 m^3)
- Freshwater tanks: 15,220.6 ft^3(431 m^3)
- Potable water tanks: 15,220.6 ft^3 (431 m^3)

The hull of the FLNGVs would be double-hull construction and designed in accordance with codes requiring arrangements allowing visual inspection of at least one side of the inner hull structure and insulation located in the hold spaces (per IMO IGC, Chapter 3 – Ship Arrangement). This would allow periodic inspections to identify any damage that may present a future safety issue with the FLNGV. The cargo hold area would consist of eight LNG storage tanks arranged in a double-row configuration. The storage tank arrangement would ensure adequate stability and longitudinal strength during operation and provide the required minimum storage capacity. Each FLNGV would have a nominal storage capacity of 210,000 m^3 utilizing Gaztransport & Technigaz Mark-III membrane-type LNG storage tanks. Hold spaces would be separated from machinery spaces, accommodations, service spaces, control stations, potable and

Figure 2.2-4. Artist's Rendering of Port Delfin Layout

freshwater tanks, and non-cargo fuel tanks. Each tank would have two LNG offloading pumps to transfer LNG from the tank to the LNG offloading header. The pumps would have the capacity to transfer LNG at a total flow rate of 9,000 m^3 per hour. LNGCs would berth alongside the FLNGV and receive LNG via offloading arms or cryogenic hoses on the starboard side midship of the FLNGV.

2.2.7 LNG Carriers

Delfin LNG anticipates that up to 40 LNGCs would call on the proposed Port per FLNGV per year. This would result in a total of 160 LNGC calls per year to the proposed Port. LNGCs calling on the proposed Port would be compatible with the proposed Project's offloading system and able to operate within the safety specifications of the proposed Port. LNGCs operating at the proposed Port would comply with all applicable Federal and State laws and regulations as well as certified by their flag states and compliant with all international safety and pollution prevention requirements applicable to LNGCs. LNGCs calling on the proposed Port would first obtain a Certificate of Compliance issued by the USCG per 46 Code of Federal Regulations (CFR) Part 154 which would include examination of documents and select drawings as well as conducting a physical inspection of the LNGC. Prior to being authorized to call on the proposed Port, all LNGCs would complete a vetting and compatibility study in accordance with general practice in the global LNG industry.

LNGCs calling on the proposed Port would range in size from 125,000 m^3 to 177,000 m^3. The entire offloading of cargo from the FLNGV to the LNGC, including berthing and sail away, would be approximately 36 hours for a 170,000 m^3 LNGC (Table 2.2-2). Preferably, the berthing and sail away of the LNGC would occur during daylight hours.

Table 2.2-2. Offloading Sequence

LNGC Operations	Estimated Time (Hours)	Cumulative Time (Hours)
LNGC Arrival at Safety Zone		0.0
Berthing LNGC	3.0	3.0
LNGC Fast alongside	0.0	3.0
Pre-LNG transfer conference	1.0	4.0
Safety inspection (in parallel)	0.5	4.0
Connect and purge hoses	3.0	7.0
Hose cool down and leak test	1.0	8.0
LNG Transfer (170,000m³ LNGC)		
Ramp up	1.0	9.0
Approximate full rate 8-9,000 m^3	21.0	30.0
Top off	2.0	32.0
LNGC Disconnect		
Purge and disconnect hoses	3.0	35.0
Reconnect 2 tugs for departure assist	0.5	35.5
Disconnect moorings and maneuver off	0.5	36.0
LNGC sail way – outside Safety Zone	0.0	36.0

Key:
LNGC = liquefied natural gas carrier
m^3 = cubic meters

2.2.8 Onshore Facilities

Several onshore facilities would be required for construction and operation of the proposed Project. No DOT-defined high consequence areas are present in the vicinity of the proposed onshore facilities. Onshore facilities required would include:

- meter station,
- new compressor station,
- onshore portion of the UTOS 42-inch pipeline, and
- gas supply header pipeline.

Delfin LNG would design the proposed DOF gas systems to have a MAOP of 1,250 psig.

2.2.8.1 Meter Station

In order to meter and regulate the quality of gas supplied to the Port, a new meter station would need to be installed at the interconnection with existing natural gas pipelines at Transco Station 44. Potential existing natural gas pipelines that could supply gas to the Port include ANR Pipeline Company, Natural Gas Pipeline Company of America, Tennessee Gas Pipeline, and Transco. Delfin LNG currently owns lease rights to construct and operate the meter station at this location. Each interconnection would require a separate meter with a separate operator/owner designation.

The meter station would require an approximately 200-ft by 150-ft area for the necessary equipment. The area would be graveled and fenced. Equipment required for the meter station would include multiple ultrasonic meters and switching valves as well as individual flow computers/remote terminal units or a common gas chromatograph for each interconnection. Overpressure protection controls would also be required for each interconnection that has a MAOP greater than the DOF mainline. All new facilities related to the meter station proposed by Delfin LNG would be constructed within the existing fenceline of Transco Station 44.

2.2.8.2 Compressor Station

A 120,000 hp ISO compressor station would be constructed to push the gas from the interconnection with existing gas infrastructure to the proposed Port. On September 12, 2015, Delfin LNG purchased from PSI Midstream Partners, L.P. (PSI) the property on which the compressor station would be located. The following equipment would be required for the compressor station:

- four 30,000 hp Solar Titan 250 gas turbine-driven compressors;
- four gas coolers;
- three natural gas-fired, 600-kilowatt Waukesha VHP 3604 generators with Waukesha F3524GSI engines;
- two control buildings;
- office and warehouse buildings;
- pig[17] launcher; and
- check meter.

Within the compressor station site, Delfin LNG would require the construction of pig launcher and check meter facilities. The check meter would consist of multiple ultrasonic meters with switching valves as well as flow control valve(s) to control the quantity of gas transported to the FLNGVs. Over-pressure protection would be provided in the control system.

[17] A pig is an internal tool that can be used to clean and dry a pipeline and/or to inspect it for damage or corrosion.

The compressors, generators, and the two control buildings would be constructed on platforms elevated 25 ft above the ground surface in order to provide storm-surge protection. The compressors would be contained within two 80-ft by 100-ft compressor buildings (two compressors per building). The buildings would have an approximate total height of 70 ft above the ground surface. The three generators would be contained in a 40-ft by 80-ft building with a total height of 60 ft above the ground surface. The two control buildings would each be 15 ft by 55 ft with an approximate total height of 41 ft above the ground surface.

In addition to the buildings described above, Delfin LNG would purchase the Johnson Bayou Community Center to be utilized for office space. Delfin LNG is currently negotiating with the Johnson Bayou Recreation District regarding the sale of the building and the construction of a new building at a different location in Johnson Bayou. As of September 14, 2016, a location has not been selected nor has any current landowner for a potential new location been contacted in connection with this transaction. The selected parcel would be between 1.2 and 2 acres in size and would house the same amenities (bathrooms, storage room, kitchen area, oven, refrigerator, small stage, elevator, etc.) as well as improved parking. The new community center would be constructed in approximately 5 to 8 months and would be approximately 85 ft by 85 ft in size. Delfin LNG intends to use the existing engineering drawings for the current community center as a template for construction of the new community center. Delfin LNG would also construct a new warehouse. The warehouse would be 50 ft by 100 ft with a total height of 35 ft above the ground surface and would be constructed in April-July 2018.

2.2.8.3 UTOS Onshore Pipeline

The existing UTOS onshore pipeline is 42 inches in diameter and includes a mainline block valve and blowdowns south of Louisiana Highway 82. The UTOS onshore pipeline extends from the mean high water mark for approximately 1.1 miles to the Transco Station 44 property boundary. As part of the proposed Project, these facilities would be placed back into service and dedicated to the Delfin LNG Project. Delfin LNG would maintain a 50-ft-wide permanent easement during operation of the UTOS onshore pipeline.

2.2.8.4 Gas Supply Header

The gas supply header would transport gas from the meter station site to the compressor station. The gas supply header would include approximately 0.25 mile of new 42-inch-diameter pipeline to connect the existing UTOS onshore pipeline with the meter station. Approximately 0.6 mile of two new 30-inch-diameter pipelines would extend from the meter station to the compressor station. The twin 30-inch-diameter pipelines would be maintained in a permanent 70-ft-wide right-of-way and buried to provide 36 inches of cover. An easement agreement with PSI has been reached for the supply header on PSI-owned property outside the limits of the compressor station.

2.2.9 Construction and Installation

Construction of the proposed Project would begin third quarter 2017 for the proposed DOF, which would be constructed in two phases. Onshore construction would be completed by the end of third quarter 2020. Construction of the offshore components of the proposed Project would begin at the end of the first quarter 2018 and completed in four phases. Each phase would be constructed approximately 12 months apart with all four FLNGVs fully operational by summer 2022.

There would be no need for any new or expanded construction, laydown, or parking areas to construct the proposed Project outside of the proposed DOF footprint. All necessary work areas would be within the DOF footprint and are included in this analysis. Delfin LNG would use existing Gulf of Mexico fabrication and pipeline yards. The U.S.-based construction associated with the proposed Project would be limited in scope and could be accommodated within the existing permitted footprints of several existing offshore fabrication and pipeline facilities.

2.2.9.1 Offshore Facilities

Construction of the offshore components of the proposed Project would begin with the construction of the proposed WC 167 bypass, followed by construction of the four pipeline laterals and subsea isolation valve to each of the FLNGV locations. The final stage of construction would be the construction of the TYMS, beginning with the installation of the piles, connection of the mooring tower, and finally the installation of the riser. At this time, the four service vessel moorings would also be constructed. During construction, Delfin LNG would utilize a number of construction vessels that would require various types of anchoring. Table 2.2-3 provides impacts associated with all construction vessel anchorages.

The UTOS and HIOS pipelines have undergone a due diligence study to determine their integrity and reliability. Based on that review, UPI determined that it is reasonable to assume that the existing UTOS and HIOS pipelines can be operated safely and reliably. Delfin LNG would conduct pipeline integrity testing in 2018, prior to commencing operations at the proposed Port. The hydrostatic testing would be performed in conjunction with the testing for the WC 167 bypass and pipeline laterals. All piping would be hydrostatically tested to 1.25 times the 1,250 psig MAOP. Inspection and testing of the pipeline would be in accordance with standard industry practice(s) and U.S. Department of Transportation (DOT) Pipeline and Hazardous Materials Safety Administration guidance.

Table 2.2-3. Moored Vessel Operations and Anchor Activity a/

Vessel Activity	Vessel	Total Days Moored	No. of Times Setting Anchors	No. of Anchors on Vessel	Max Anchor drag (ft.)	Affected Seafloor (acres)
WC 167 Bypass pipeline All work by DSV						
Install and trench 700' bypass pipeline	DSV	70	2	4	132	0.025
Install 4 pipeline laterals All 4 laterals installed first year						
Pipelay of 4 laterals	Lay/ Trench Barge	14	12	8	180	0.041
Flood and hydrotest of 4 laterals	DSV	12	8	4	132	0.025
Trenching of 4 laterals	Lay/ Trench Barge	13	12	8	180	0.041
Connect 4 pipeline laterals to Main Line All 4 laterals installed first year						
Install 4 hot tap tees and perform hot taps	DSV	62	8	4	132	0.025
Install 4 spool connections to main line	DSV	16	4	4	132	0.025
Pre-commissioning						
Pre-commission the System	DSV	49	2	4	132	0.025
TYMS Installation One TYMS first year. TYMS added as expansion progress Fully developed (x 4)						
Installation of TYMS	Derrick Barge	43 (172)	1 (4)	8	180	0.041
Installation of tie-in spool connections to TYMS	DSV	3 (12)	1 (4)	4	132	0.025
Total						**0.273**

Note:
a/ Assumes a 5-ton anchor (DSV) is 8 feet wide and a 10-ton anchor (barge) is 10 feet wide.

Prior to beginning construction activities, gas flowing along the HIOS pipeline from the HI A264 platform to the WC 167 offshore manifold platform would be shut off and pushed from the line. The line would then be filled with mono ethylene glycol and pushed with nitrogen. The pipe would then be cleaned and flooded with filtered seawater. Similarly, the UTOS pipeline, which is already dry and filled with nitrogen, would be cleaned and filled with filtered seawater.

Delfin LNG intends to contract with one of several offshore pipeline construction firms with existing facilities for prefabrication of the WC 167 bypass and pipeline lateral components. These components could include the pipeline, fitting spools, valve assemblies, hot-tap assemblies, concrete mats, and tie-in spools. As stated above, there would be no need for new facilities, parking, or laydown areas. Potential facilities include the following:

- Chet Morrison Contractors – Houma, Louisiana
- Bisso Marine – New Orleans, Louisiana
- EMAS – Ingleside, Texas
- Subsea 7 – Port Isabel, Texas

WC 167 Bypass

Delfin LNG anticipates that construction of the WC 167 bypass would occur from March through June 2018. Prior to any work being performed, Delfin LNG would conduct a survey for other existing infrastructure within 300 ft of the WC 167 offshore manifold platform using a remotely operated vehicle and magnetometer. This would provide the accurate position of any existing pipeline infrastructure to facilitate excavation and construction of the WC 167 bypass. Any pipelines identified would be exposed and dredging completed below the pipeline via a diver-operated jet pump suction dredge. The dredged material would be deposited in a designated spoil area for backfill after completion of the work.

A four-point mooring dive support vessel and a team of surface divers would be required during construction. The dive support vessel would remain on-site during construction and be utilized as a platform from which the work would be conducted. The dive support vessel would be outfitted with a 50-ton crane to lower bypass spools to the seafloor.

The WC 167 bypass would be constructed using 42-inch-diameter flanged line pipe spools. The spools would be 160 to 200 ft in length and constructed using standard 40-ft joints. The bypass spool pieces, bend spoils, and final closing spool would all be fabricated on shore. All necessary hydrotesting would be done on shore prior to the pieces being transported to the site.

Prior to installation of the WC 167 bypass, divers would demarcate the specific tie-in points. The entire pipeline at the tie-in locations would be exposed using a jet pump suction dredge for jetting. Flanged line pipe spools would be installed using bolt jacks to make up the connections between the existing pipeline and bypass spools.

Excavation of the trench would be completed using a trenching machine operated and towed behind the trench vessel. The trench would be excavated to a sufficient depth to allow at least 3 ft of cover between the seafloor and the top of pipe. In areas where the WC 167 bypass would cross foreign pipelines, two layers of concrete mattresses above or below the crossed pipelines would be installed. Table 2.2-4 provides impacts associated with installation of the WC 167 bypass and pipeline laterals.

Table 2.2-4. Pipeline Lateral and WC 167 Bypass Impacts

Pipeline Type	Bottom of Trench a/ (feet)	Pipeline Lowering Method	Length (feet)	Volume Displaced b/ (cubic yards)	Total Impact (acres)
30-Inch Laterals	10	Jetting Sled and connections	25,600	51,200	58.76
WC 167 Bypass (42-inch)	10	Jetting Sled and connections	700	1,400	1.60
		Total Temporary Impact	**26,300**	**52,600**	**60.36**

Notes:
a/ Trenches are assumed to impact a 100-foot width along the centerline.
b/ Displacement based on 2 yards per foot (MMS 2001).

Pipeline Laterals

Construction of the four pipeline laterals would occur from April through October 2018 during the first phase of offshore construction. Construction would require the use of a laybarge with 70-ton crane, four welding statins, and pipe tensioners. In addition to the laybarge, a pipe haul barge and tugboat would also be required for installation.

Excavation of the trench would be completed using a jet plow. The trench would be excavated to a sufficient depth to allow at least 3 ft of cover between the seafloor and the top of pipe. Impacts from construction of the pipeline laterals are provided above in Table 2.2-4. Once the trench has been excavated, an installation anchor would be set and tested where the first segment of the pipeline would be tied off for lay initiation. The pipe would then be placed in the trench using the S-lay mode pipelay installation. Delfin LNG anticipates that pipelaying for all four pipeline laterals would be approximately 21 days. The same barge utilized for pipelaying would also be utilized for trenching.

After installation is complete, the pipeline laterals would be flooded and cleaned with filtered seawater and hydrostatically tested. Each lateral would be tested to 1.25 times its MAOP of 1,250 psig. The hydrostatic testing would occur for an 8-hour period. To conduct the testing, Delfin LNG would utilize a four-point moored dive support vessel with surface divers. It is anticipated that the same four-point moored dive support vessel with a team of surface divers would be used for hot-tapping and to install the subsea spools.

Prior to tie-in with the HIOS pipeline, divers would demarcate the four branch-off points (tie-in points) along the HIOS pipeline. The entire pipeline at the tie-in locations would be exposed using a jet pump suction dredge for jetting and dredging underneath the pipeline laterals. The exposed area would need to allow enough workspace for the hot-tap clamp and flange, the machinery for penetrating the pipeline, and clearance for divers to safely perform the work. The dredged material would be deposited in a designated spoil area for possible future re-use.

Prior to installing the clamp on the HIOS pipeline at the tie-in locations, the existing concrete coating would be removed. Divers would set up the split tees at the correct locations and bolt them around the perimeter of the HIOS pipeline in order for them to perform as a single unit. A valve assembly would then be flanged into the fitting and pressure tested.

The hot-tap cutter would then cut and remove a section of the HIOS pipeline. The operation would be performed in one continuous process. The gate valve would then be closed and divers would begin work on excavating a trench from the end of the pipeline lateral to the tee. The pre-tested subsea spools would then be installed and concrete mattresses (20 ft by 8 ft in size and 9 inches thick) would be installed over the spool pieces.

Once the tap is completed at all four pipeline lateral tie-ins, Delfin LNG would fill the pipeline laterals and HIOS pipeline with water. The entire system would then undergo a non-destructive leak test. Once completed, the system would be dewatered using nitrogen, mono ethylene glycol slugs, and pigged before being vacuum dried and packed with nitrogen.

TYMS

Delfin LNG anticipates that installation of the TYMS would require four piles, one for each leg. However, the final number of piles would be determined during detailed design. The piles would be 78 inches in diameter and approximately 300 ft in length. Prior to construction activities, all existing pipelines in the immediate area would be located and marked. Once the existing pipelines have been identified, anchor handling tugs would set the derrick barge anchors in locations using established safety zones from existing pipelines.

A material barge containing the jacket structure and piling would be towed to the TYMS site and moored to the side of the derrick barge. Using lifting slings, the derrick barge would lift the jacket and placed on the seafloor in the pre-designated location. Table 2.2-5 identifies the permanent impacts from TYMS installation.

Table 2.2-5. TYMS Installation Impacts

Description	Quantity	Unit Impact (feet)	Total Impact(acres)
TYMS			
Pilings with Jackets	4	1,681	0.15
		Total Permanent Impacts	**0.15**

The pilings would be installed in sections using a steam or hydraulic pile-driving hammer. After each section is driven to grade, the next section would be welded to the preceding one, tested for integrity, and driven to grade. The process would be repeated until the installation is complete at which time the top of the pile would be welded to the top of the jacket leg. The pilings would be installed to a depth of 250 to 300 ft below the seafloor; however, final depth would be determined during the final design. After piling installation is completed, the tops of the piles would be cut to the pre-designated elevation and angle.

The riser would be transported to the TYMS location already clamped to the jacket structure. Once the jacket is in place, a diver-operated jet pump would remove soil below the riser to a depth of approximately 8 ft below the seafloor. The riser would then be lowered from the jacket and a trench excavated via diver-operated jet pump between the pipeline lateral and riser. The subsea spool would be prefabricated and hydrotested on shore prior to installation. Two pigs would be installed at the lateral end of the spool for later use. Divers would then install the spool piece connecting the riser to the pipeline lateral using jack bolts to make up flanged connections. Once installation is complete, the trench would be backfilled.

The superstructure, which includes structural components, piping, and mooring swivel, would be transported to the TYMS site via material barge, which would be moored to the derrick barge. The superstructure would then be lifted in place and welded to the jacket/piling structure. Navigation lights and sound signals would be tested prior to the derrick barge leaving the site.

Delfin LNG proposes the use of an existing facility as a fabrication yard with the ability to construct the TYMS and associated components. Project-related activities would occur within the existing footprint and there would be no need for any new or expanded laydown, fabrication, or parking areas. Potential facilities include the following:

- Gulf Island Fabrication – Houma, Louisiana
- Gulf Marine Fabricators – Ingleside, Texas
- Kiewit Offshore Services – Ingleside, Texas

- Twin Brothers Marine – S. Louisa, Louisiana

Service Vessel Mooring

The service vessel mooring would be installed subsequent to the TYMS. Concrete anchors would be lifted from a derrick barge and lowered to the designated location on the seafloor. The anchor chain, mooring line, and buoy assembly would already be attached to the anchor. No jetting or driving into position would be required for the anchor. Once in place, lights would be installed, tested, and activated.

2.2.9.2 Delfin Onshore Facility

The proposed DOF would be constructed in two stages. DOF construction activities would occur from 6 a.m. to 10 p.m. daily. During the first stage, Delfin LNG would construct the following:

- the gas supply header;
- meter station;
- elevated foundations for all compressor, generator, and control buildings;
- two of four 30,000 hp Solar Titan 250, gas-fired turbine compressor packages;
- two of four gas coolers; and
- all three natural gas-fired, 600-kilowatt Waukesha VHP 3604 generators.

The first stage would begin construction in September 2017 and be completed in October 2018 and would include construction of all buildings with the exception of the second compressor building.

The second stage would begin construction in January 2020 and be completed in October 2020. During the second stage, Delfin LNG would construct the remaining two 30,000 hp Solar Titan 250, gas-fired turbine compressor packages and two gas coolers. The second compressor building would be constructed at this time to house the two remaining compressor packages and two gas coolers.

Aboveground Facilities

Aboveground facilities would be constructed in five main steps; clearing and grading, foundation and platform construction, equipment installation, hydrostatic testing, and restoration.

Clearing and Grading

Prior to construction, all aboveground facility footprints and required additional temporary workspace would be cleared of any large obstacles such as trees, boulders, logs, etc. Timber and other suitable vegetative debris would be chipped and utilized as mulch for erosion control or disposed of per landowner requirements or in accordance with applicable local regulations. Once large obstacles are removed from the construction workspace, the site would be graded to create a level working surface to allow the safe passage of construction equipment. Sensitive resources such as wetlands and waterbodies would be marked with appropriate setbacks. Temporary erosion controls would be installed immediately following initial earth disturbance activities and maintained and/or reinstalled as needed until permanent erosion controls can be installed or the site is restored.

Foundation and Platform Construction

Delfin LNG would install piles approximately 180 ft below the ground surface to support the elevated platforms. The piles would rise approximately 20 ft above the ground surface on which pile caps and pre-stressed concrete slabs would be installed. The compressor, generator, and control building would then be placed on their respective platforms.

For on-grade buildings, such as the warehouse, Delfin LNG would set the forms, install rebar, and pour and cure the concrete foundations per applicable industry standards. Backfill would be compacted in place and excess material would be used elsewhere, as needed, around the site.

Equipment Installation

Necessary equipment would be shipped to the proposed DOF and offloaded with cranes or other equipment and stored on-site within the additional temporary workspace until it is ready to be installed. The equipment would then be placed on the elevated platforms or foundation, leveled, grouted where necessary, and secured with anchor bolts.

Non-screwed piping would be welded except where connected to flanged components. Welders and welding procedures would be in accordance with American Petroleum Institute and American Society of Mechanical Engineers standards. Welds would be examined using radiography, ultrasound, or other approved methods to ensure compliance with all applicable codes. Once installed, all aboveground piping would be cleaned and painted.

Hydrostatic Testing

In accordance with DOT requirements (49 CFR Part 192), all high-pressure gas components would be hydrostatically tested for 8 hours prior to being placed into service. Any leaks would be repaired and retested. The approximately 200,000 gallons of hydrostatic test water required would be obtained from municipal/parish sources. Hydrostatic test water would be re-used between the proposed DOF, with the exception of the UTOS onshore pipeline that would be tested with the offshore portion of the UTOS pipeline.

Water used for hydrostatic testing would only be in contact with new pipe and no chemicals would be added. No chemicals or desiccant would be used to dry the pipe. Delfin LNG would not discharge hydrostatic test water into the surrounding surface water or over land. All hydrostatic test water would be placed in holding tanks and hauled off-site to an approved, permitted facility for disposal.

Restoration

Delfin LNG would follow the FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan* (FERC Plan [FERC 2013]) and Delfin LNG's *Wetland and Waterbody Construction and Mitigation Procedures* (Delfin LNG Procedures; see Appendix F).[18] Delfin LNG's Procedures are based on the FERC's *Wetland and Waterbody Construction and Mitigation Procedures*, with several exceptions addressing necessary Project work in a disturbed wetland. FERC staff has reviewed these exceptions and finds them acceptable. The majority of the area used for construction would remain in use for operation. Areas around the compressor station and associated piping and equipment would be covered with crushed rock. Disturbed roads and parking areas would be re-covered with crushed rock, asphalt, or concrete, as appropriate. Areas within the fenceline that are not required for operation would be seeded with a seed mix that is appropriate for the climate and easily maintained. All additional temporary workspace would be returned to pre-existing grades and contours restored to be compatible with surrounding drainage patterns.

Gas Supply Header

Delfin LNG would employ conventional cross-country pipeline construction techniques to install the gas supply header. Work would be conducted as shown in Figure 2.2-5 as one continuous operation to minimize the amount of time a tract of land is disturbed. The stages of typical pipeline construction procedures are described below.

[18] The FERC Plan and Procedures are a set of construction and mitigation measures that were developed in collaboration with other Federal and State agencies and the natural gas pipeline industry to minimize the potential environmental impacts of the construction of pipeline projects in general. The FERC Plan can be viewed on the FERC Internet website at http://www.ferc.gov/industries/gas/enviro/plan.pdf. The FERC Procedures can be viewed on the FERC Internet website at http://www.ferc.gov/industries/gas/enviro/procedures.pdf.

Clearing and Grading

Clearing and grading crews would remove vegetation and obstacles from the construction right-of-way and temporary workspaces required for construction. This would include trees (as necessary), stumps, logs, brush, and large rocks. Timber and other suitable vegetative debris would be chipped and utilized as mulch for erosion control or disposed of per landowner requirements or in accordance with applicable local regulations.

Sensitive resources such as wetlands and waterbodies would be marked with appropriate setbacks. Temporary erosion controls would be installed immediately following initial earth disturbance activities and maintained and/or reinstalled as needed until permanent erosion controls can be installed or the site is restored.

Trenching

Trenching would be conducted by a track-mounted excavator. Typically, the trench would be excavated to a depth sufficient to provide 3 ft of soil cover over the top of the pipe after backfilling. The bottom of the trench would be excavated at least 12 inches wider than the diameter of the pipe.

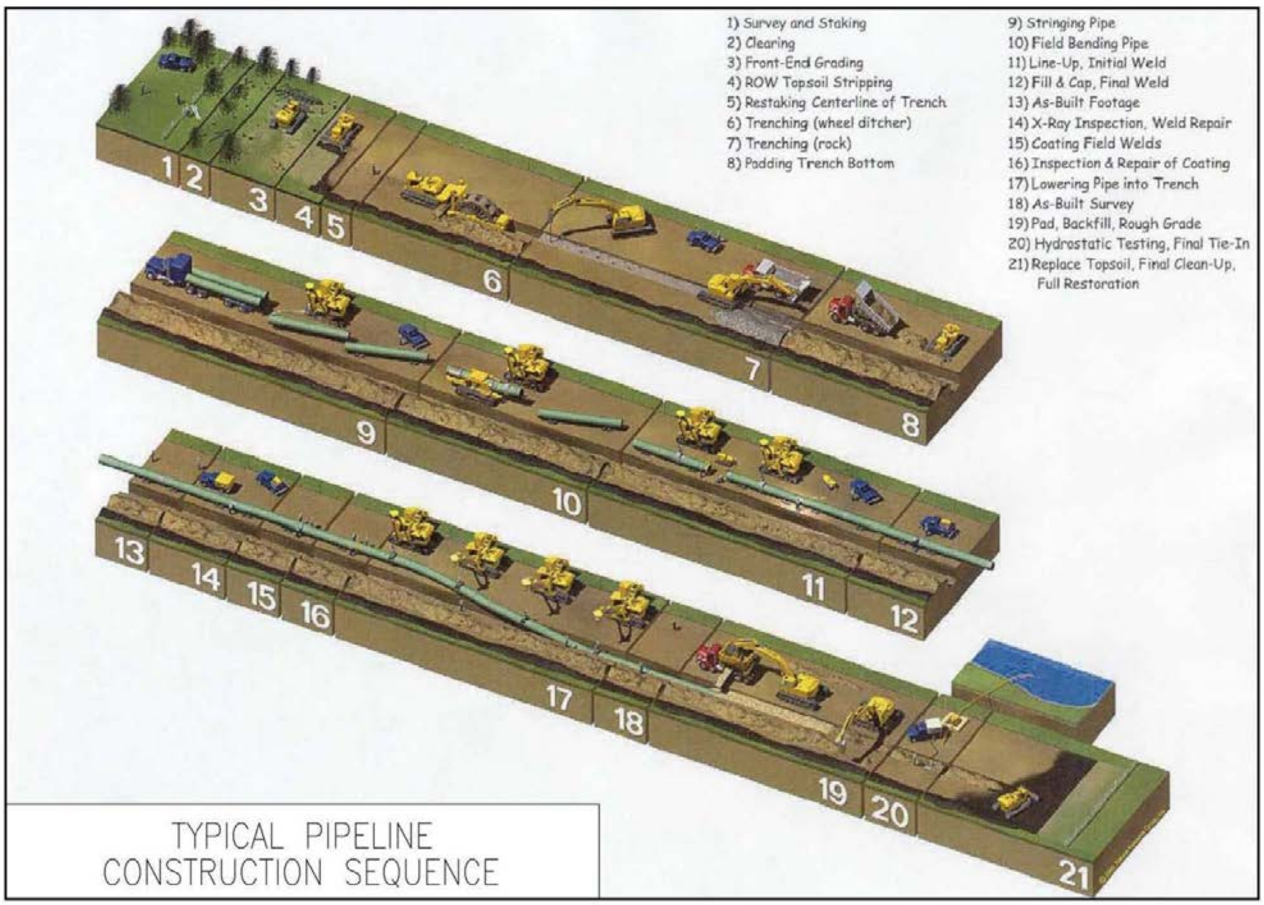


Figure 2.2-5. Typical Pipeline Construction Sequence

Excavated soil would be stockpiled along the right-of-way away from construction traffic and the pipe assembly area (the "spoil side"). In areas such as wetlands or those where otherwise requested, Delfin LNG would segregate topsoil for the full width of the construction right-of-way. Topsoil would be removed to a typical depth of 12 inches over the trench and spoil areas and stockpiled separately from subsoil as to avoid mixing.

Pipe Stringing, Bending, Welding, and Coating

Pipe would be delivered to the proposed DOF in 40-ft lengths or “joints.” The pipe would be protected on the outside using a fusion-bonded epoxy coating and an abrasion-free overlay applied at the factory. Joints would then be brought to the cleared and graded right-of-way where it would be strung adjacent to the trench. Bends in the pipe may be needed for direction changes, as well as natural grade changes. Prior to welding, select joints would be bent in the field by track-mounted hydraulic bending machines. Following stringing and bending, the pipe would be placed on supports to weld segments of pipe together. The pipe arrives with a protective coating with the ends uncoated where they will be welded together using multiple passes to provide a full-penetration weld. Once welded, these areas are coated by a coating crew. The pipe would then be inspected for defects in the coating and welds and repaired as needed before installation in the trench.

Lowering In and Backfilling

After inspection of the trench to ensure it is free of rocks and other debris that could damage the pipe, the pipe would be lowered into the trench using side-boom tractors. After the pipe is in position, the trench would be backfilled with the previously excavated material. Screened fill would be placed around the pipe prior to backfilling if the excavated material contains large rocks or other material that could damage the pipe or its coating. Where topsoil is required to be stored separately from subsoil, the subsoil would be backfilled first, followed by replacement of the topsoil. Topsoil would not be used to pad the pipe.

Hydrostatic Testing

Hydrostatic testing would be performed as described above for the aboveground facilities.

Cleanup and Restoration

All work areas would be graded to match pre-construction contours. Erosion control methods would be implemented and could include contouring, permanent slope breakers, mulch, and re-seeding or sodding with soil-holding grasses. Delfin LNG would restore fences, gates, driveways, and roadways affected by construction to original or better condition.

Wetlands

Silt fences would be installed at the edges of the construction right-of-way where spoil could migrate into undisturbed portions of the wetland. Vegetation would be cut off at ground level. Tree stump removal and grading would be limited to the area directly over the trench unless safety-related construction constraints require otherwise. Trench plugs, such as sack breakers or foam breakers, would be installed at the entry and exit points, if necessary to maintain wetland hydrology and to minimize the flow of water to and from the trench. Topsoil would be segregated from the subsoil and stored in unsaturated areas. Specific wetland crossing procedures would depend on the level of soil stability and saturation encountered during construction. Original topographic conditions and contours would be restored as nearly as practicable following construction.

2.2.10 Operations

Gas from existing onshore natural gas pipeline systems would be received at the proposed DOF meter station and transferred to the compressor station where it would then be transported via the UTOS/HIOS pipeline to the TYMS. From the TYMS, it would be transported through the riser and into the FLNGV storage tanks for offloading onto calling LNGCs for transport around the world. Delfin LNG anticipates that each of the four FLNGVs would be called on by 40 LNGCs per year. This would total 160 LNGC calls per year for the entire proposed Port. The offloading time would be 36 hours from LNGC berthing to offloading to sail away.

Delfin LNG would work with its flag state to establish appropriate manning requirements for the FLNGVs that only intend to act as vessels in navigation for short periods of time (especially for storm evasion). Delfin LNG has expressed and continues to maintain a preference for hiring U.S. licensed and documented mariners to man the FLNGVs. While final details of Delfin LNG's anticipated manning scheme would be developed during the detailed design engineering phase, Delfin LNG currently expects that the manning complement of each FLNGV would consist of 6 licensed officers and 8 to 14 documented mariners for a total of between 14 and 20 mariners per FLNGV (56 to 80 mariners for the fully constructed project).

2.2.10.1 Offshore Facilities

The FLNGVs would be moored to the TYMS where gas would be received through the riser from the existing UTOS/HIOS pipelines. During transport from the proposed DOF to the TYMS, some liquid condensate could collect in the pipeline and result in occasional condensate slugs. The condensate slugs would be collected in the inlet separator locating on the TYMS and transported to the condensate storage tank.

Feed gas would be routed to the inlet filter coalescer to capture trace liquids contained in the gas prior to going through the gas metering skid which is used to control and monitor the process. The gas leaving the gas metering skid is then sent to feed pretreatment and the liquefaction systems.

The metered gas would then be processed in the gas/amine contactor to remove impurities such as carbon dioxide and hydrogen sulfide. Acid gases would be stripped from the amine and routed to a thermal oxidizer for elimination of sulfur byproducts and other hazardous air pollutants. The regenerated amine is then recycled by the contactor.

Sweet and wet gas from the gas/amine contactor would be first cooled to reduce moisture content and fed to a dehydration unit where it is dried in molecular sieve beds. Sieve dust in the gas is then removed and the dry gas used to regenerate the dehydration beds and also as make-up fuel gas. After dehydration, mercury is removed from the gas using a metal oxide-based or sulfur-impregnated activated carbon absorbent where mercury is reduced to less than 0.01 microgram per m^3.

The gas would then be fed to the three liquefaction trains that would be located on the topsides of each FLNGV. Each liquefaction train would contain a heavy hydrocarbon removal unit to remove heavy components that would be prone to freezing at the cold operating temperatures in the liquefaction unit. The feed gas is then cooled to cryogenic temperatures and converted to liquid at which time it is transferred into the storage tanks before being transferred a calling LNGC. A diagram outlining the liquefaction process is provided as Figure 2.2-6. Boil-off gas compressors would be installed to handle the holding and LNGC loading modes of operation.

FLNGV Operations

The FLNGV would use air cooling to support the liquefaction process, generate its electrical power, and produce and store demineralized water, freshwater, and potable water for process. Other required utilities on the FLNGV would include compressed air, the nitrogen generator, wastewater treatment, and sanitary sewer treatment.

LNG Storage

The FLNGV would have an LNG storage capacity of 210,000 m^3. The tanks would operate at an absolute pressure of between 1.025 and 1.060 bar-a. Two LNG loading pumps would send LNG from the tank to the LNG offloading header at a rate of 9,000 m^3 per hour.

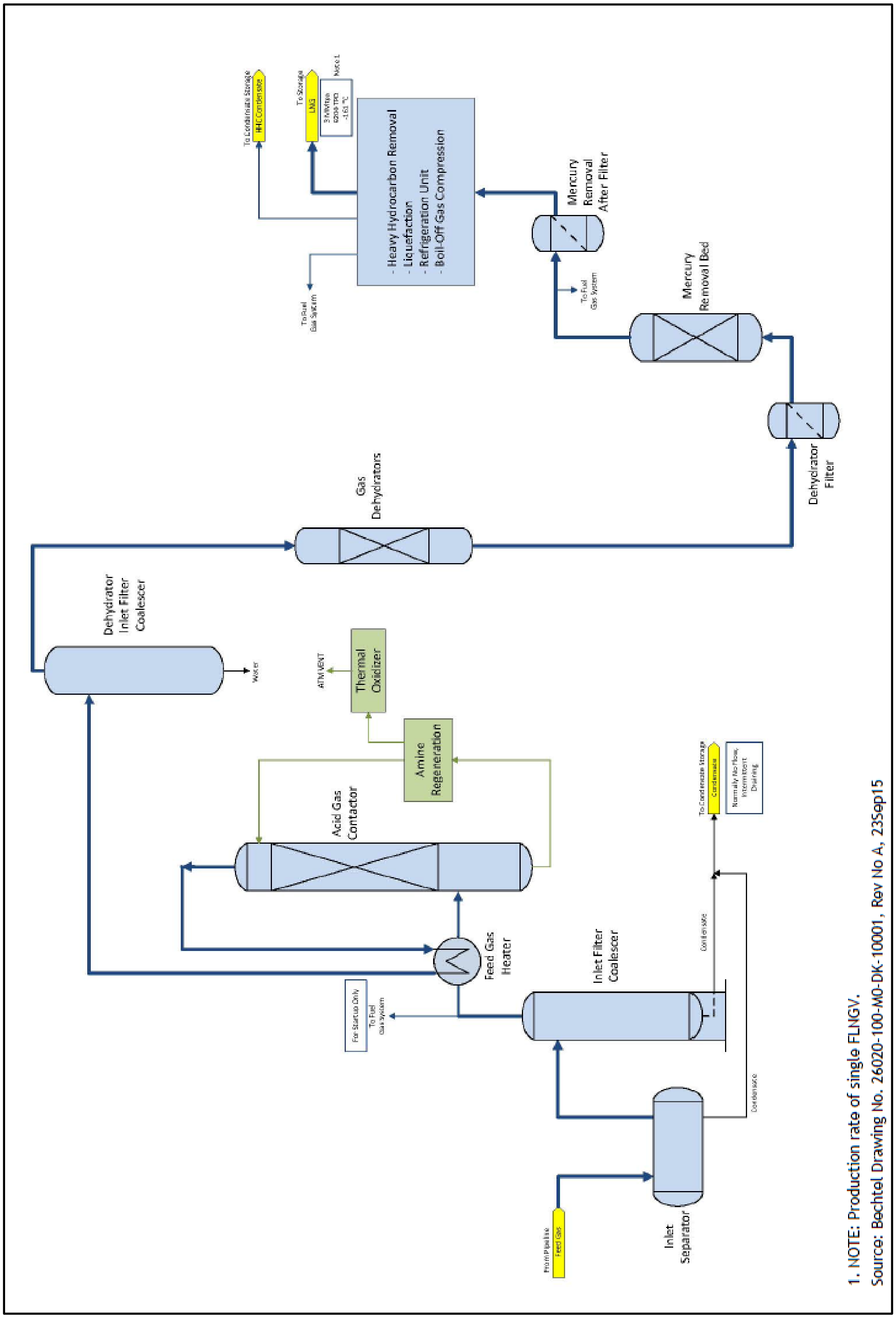


Figure 2.2-6. FLNGV Liquefaction Technology

Condensate Storage

For the most part, condensate removed during various processes of operation would be flashed and the flashed vapors used as fuel gas. Any excess condensate would be collected and stored in two condensate storage tanks for removal from the FLNGV by supply boat. Condensate would be removed from the FLNGV approximately every 120 days for sale.

Fuel Gas System

The fuel gas skid would be designed to provide high-, medium-, and low-pressure fuel gas to meet user requirements. Assuming the gaseous components of the heavy hydrocarbons and condensate would be added to the fuel gas system, the fuel gas unit would be able to meet the fuel gas requirements of the FLNGVs.

Heating Medium (Synthetic Oil)/Waste Heat Recovery System

Synthetic oil would be circulated in a closed-loop system and located on the topsides except for the make-up oil storage tank. The process heating system would be provided by synthetic oil. The synthetic oil would be heated in the waste heat recovery units where waste stack gas from the turbine generators would pass over a coil containing the synthetic oil. Heated synthetic oil would be distributed to its users via the hot oil supply header and would return to the hot oil expansion tank through the hot oil collection header.

Fuel Oil System

A fuel system, including marine diesel oil purifiers, settling tanks, and transfer pumps, would be provided in which marine diesel oil would be used as a fuel oil. The fuel oil system would be provided in the hull and transfer fuel to the day tanks for the essential generator, emergency generator, firewater pumps, and other equipment. The marine diesel oil would be stored in service tanks and sent to the gas turbine, topsides, service tanks for essential diesel generators, or the emergency diesel generator tank. The marine diesel oil to emergency generators would be for start-up, emergency use only.

Main Power Generation

Electrical power would be self-generated based on a peak electrical load during ship-loading operation at the LNGC. Three gas turbine generators (at 50 percent load), equipped with waste heat recovery units for heating hot oil, low-nitrogen oxides emission system, and dual-fuel capability would be used to generate the main power for the FLNGV.

Essential Power Generation

Three, 6.45-megawatt, dual-fuel and dual-power (diesel and electric) generators would be provided for the hull propulsion system and for supplying power to the utility systems in the hull when in transit. All three essential generators would be used to provide power for propulsion when FLNGVs are disconnected from the TYMS and would provide black start capability (or start up without relying on any external electric grid) of the topsides when commissioning. When the main power is provided by the gas turbine generators these generators would not be required. When the FLNGVs are moored to the TYMS, the essential generators would be maintained and tested periodically.

Emergency Power Generation

Emergency power would be provided by two independent, 760-kilowatt, diesel generators. The emergency generators would be essential for emergency power supply to life-saving equipment, firefighting systems, and telecommunications.

Seawater Treatment System

Seawater would be filtered through inlet strainers as it enters the sea chest in the FLNGV. The sea chest would be cleaned intermittently with utility air and treated with chlorine from the seawater hypochlorine generator. A diluted solution of sodium hypochlorite would also be produced in the seawater hypochlorite generator and intermittently injected into the sea chest to prevent marine and biological fouling. The seawater would then be pumped to its users to be used to generate potable, demineralized, and utility water.

Fresh, Potable, and Demineralized Water

Seawater from the seawater intake would pass through the seawater filtration system and sent to the freshwater system and be treated by the reverse osmosis unit to provide utility water. A chlorination and ultra-violet disinfection system and demineralizer treatment package would further treat the water in the potable water treatment package. Potable water would be provided to the living quarters and for other uses aboard the FLNGV. The demineralizer treatment package would include an electro-deionization unit. Demineralized water would then be pumped to the demineralization tank to supply demineralized water for use in the amine make-up and for turbine wash.

The seawater intakes would consist of two small, high sea chests and two large, low sea chests on the starboard side of the FLNGV. The sea chests would be 2.5 m by 3.5 m for the low sea chests and 1.2 m by 2.0 m for the high sea chests. The maximum intake velocity across the sea chest screens would be less than 0.5 ft per second.

Firewater/Deluge System

The firewater system would be sized to comply with applicable codes and standards. Firewater would come from the sea chest dedicated for the firewater pumps, and low-sulfur diesel firewater pumps would transport water into the water ring header and distributed as needed. In addition to hydraulic pumps, electrical jockey pumps would be utilized to maintain positive pressure in the firewater ring header.

Water Curtain

Vessel structural steels are susceptible to low temperature brittle fracturing from cryogenic LNG spills. The water curtain is designed to provide a continuous flow of water (a “curtain”) over the structure of the vessel during transfer of LNG to protect the vessel’s structure from possible contact with LNG.

Lifesaving Equipment

Safety and lifesaving equipment would be provided for all personnel on board the FLNGV and comply with the latest SOLAS requirements. Four, 50-person-capacity lifeboats would be installed at the stern with freefall davits. The lifeboats would be freefall type, totally enclosed, motor-propelled survival craft. A smaller, similar 25-person lifeboat would be provided on the bow. The davits would comply with Safety of Life at Sea (SOLAS) and the embarkation areas would be protected from fire, explosion, and smoke hazards.

A fast rescue boat meeting SOLAS requirements would be provided to facilitate rescue for a man overboard or helicopter ditching situation. The rescue boat would be powered by inboard diesel engine coupled with a water jet and would be mounted on an all-weather fast launch/recovery davit.

Open Drains

Open drains on the FLNGV would be designed to capture rainwater, firewater, and washdown including spillage of liquids from deck areas, equipment drip trays, and curbed areas. Water from the open drains would be collected in hazardous and non-hazardous area drains, each normally with their own tank. Hazardous liquids from the hazardous drain tanks would be pumped to the hull settling tank for final treatment and disposal. High-capacity deck drains from the firewater deluge would drain directly overboard via deluge drains. Drains from non-polluted areas would also be normally routed directly overboard.

Slop System

Equipment with the potential to release hydrocarbons would be designed to include drain pans to capture hydrocarbons and rainwater. The open drain system would collect rainwater, wash water, and other fluids that would be transported to the slop tanks. Two slop tanks would treat oily water by gravity separation. Oily sludge collected in the slop tanks would be routed to a hydrocyclone for separation of oil and solids. Water would be treated to 15 parts per million oil before being discharged to the Gulf of Mexico (per Marine Environment Protection Committee [MEPC] 107(49)). Treated water would be discharged at a rate of 125 gallons per minute over a 5.5-hour event on a weekly basis.

Flare/Relief/Vent System

Under normal operating or typical turndown conditions, the facilities would be designed to avoid routine flaring of hydrocarbons. Blow down, de-pressuring, and flare systems would be designed in accordance with American Petroleum Institute Standards 520 and 521. Designated flares included in the FLNGV design include:

- Wet Flare – The wet flare would handle warm hydrocarbon streams that may be saturated with water vapor and/or contain free liquid hydrocarbons and water. The flare would be provided with a dedicated knock-out drum and pump.
- Dry Flare – The dry flare would be designed to handle cryogenic hydrocarbons, both vapor and liquid and include a cold blowdown header to collect cryogenic liquid drains. This flare would be provided with a dedicated knock-out drum and vaporizer.
- Marine Flare – The marine flare is dedicated to LNG and designed to handle LNG vapors from the LNG storage tanks in the event of a failure of the boil-off gas compressors. This flare would also be used to reject contaminated or warm ship vapors during LNG loading.

Plant/Instrument Air System

The plant/instrument air system would be located in the hull and designed to meet applicable standards.

Nitrogen Generation

Nitrogen generation capacity would be based on projected needs. The nitrogen generation package would consist of multiple membrane units with multiple, isolatable banks to facilitate maintenance and replacement while online. The instrument air would pass through a protective cartridge filter before flowing into the membrane units. The unit would be designed to be capable of supplying the design flow with one of the modules out of service.

Produced nitrogen would be stored in the nitrogen buffer tank from where it would be sent to its users including the LNG train equipment purging, pad gas, compressor gas seal, makeup refrigerant gas, inert gas blanketing, and additional requirements during shutdown and turnarounds.

Water Use and Discharge Summary

The FLNGVs would have two drain systems, open drains and closed drains. Open drains would collect rainwater, wash water, and other fluids that would be drained to the slop tanks. A description of the slop tanks is provided above. The closed drain would drain closed equipment containment housings. Equipment with the potential to release hydrocarbons would be designed to include drain pans and curbing to capture released hydrocarbons and rainwater flow to the open drain system.

The process area would be curbed. Free oil collected at the top of the water layer would be removed using floating oil skimmers and routed to the oil/sludge collection tank. Oily sludge would then be separated and treated as described above for the slop system. Liquids in hazardous area drains would be pumped from the drain tanks to the hull settling tanks for final treatment and disposal before intermittently being transported to shore for disposal.

Seawater would be filtered and treated with chlorine when entering the sea chest as discussed above. Discharges for ballast systems, engine cooling systems, firewater tests, and water curtains would be limited to the sodium hypochlorite treatment. The freshwater system would operate at a 35 percent recovery rate, and reject water from the reverse osmosis demineralizer would increase the seawater salinity from 35 to 54 parts per thousand. Treated seawater would also be used as wash water for the inert gas generator (IGG) scrubber.

The use of air cooling technology would eliminate the need for the use of seawater for cooling during the LNG liquefaction process. Although the air cooling technology would not require seawater for cooling the liquefaction process, each FLNGC would still require the use of seawater for normal FLNGV operations, including ballast water, sanitary sewer, firewater, and other intermittent needs.

Continuous seawater intake would be limited to the reverse osmosis desalination system. Intermittent intakes of seawater would be made for ballast and water curtains every eight days during LNG offloading (a 24-hour period for ballast and 32-hour period for the water curtain); once-through sweater cooling for essential generator function tests and for two generators for a 29-day period each year to replace power during liquefaction system maintenance; and washing of the IGG for one 3-day period per year. The total average use for each FLNGV would be 3.036 million gallons per day. A more detailed discussion on water use and discharge is provide in Section 4.2.1.

Support Vessels and Helicopters

Delfin LNG anticipates that the onshore operations staging area would be at an existing facility in the Cameron, Louisiana, vicinity. Delfin LNG has no plans to establish any new parking, staging, or other facilities or associated parking areas to support routing offshore operations at the FLNGVs.

Operation of the proposed Project would require support equipment as described below. Supply vessels and tugboats would be owned by subcontractors and would be hired as needed.

Supply Vessels and Crewboats

Delfin LNG anticipates that partial crew changes would occur each week with a crewboat provider under contract. It is anticipated that a single weekly run would be required that would depart from Cameron, Louisiana. Each FLNGV would also require approximately one supply vessel sailing per week.

Tugboats

Delfin LNG anticipates that four tugboats would be required per FLNGV offloading operation. A single fleet of tugboats would be shared between the four FLNGVs. If arrival and departure of LNGCs overlap, one of the operations would be deferred until the tugboats complete the first operation. Delfin LNG intends to supply a dedicated fleet of four tugboats to support Project operations that would be either owned and operated by Delfin LNG or obtained from local tugboat providers under contract.

Helicopter

The FLNGVs would be equipped with helipads and would require periodic helicopter flights to support transportation of more specialized personnel who may only need to stay on board the FLNGV for one to two days. Delfin LNG anticipates that one helicopter flight per week would be necessary.

Maritime, Safety, and Related Matters

Limited access areas including Safety Zones, No Anchoring Areas (NAA), and Areas to be Avoided (ATBA) are established with varying degrees of vessel restrictions and notification requirements.

Pursuant to the regulations of the DWPA, the USCG is authorized to establish temporary and mandatory Safety Zones around deepwater ports whether or not a vessel is present. As proposed by Delfin LNG, the Safety Zone radius would be 3,005 ft (916 m) from the center of each TYMS.

In addition to the Safety Zone, an NAA and an ATBA would be established at the request of the USCG to the International Maritime Organization (IMO). As proposed by Delfin LNG, the NAA and the ATBA would have a radius of 0.8 nautical mile (1,416 m) or 500 m beyond the Safety Zone (see Section 5.5.2).

The actual size of the ATBA that would be requested of the IMO would be determined through the advice and consent of the USCG. Both the NAA and the ATBA would appear on publically available nautical charts. No vessels would be allowed to anchor in the NAA to prevent damage to the proposed Port and mooring system or damage to the proposed Port's equipment from entanglement. The restriction would likely also apply to bottom trawling for the mutual protection of the proposed Port and the fishing vessel. The ATBA is meant to discourage vessel traffic. It would help ensure that other vessels do not interfere with the proposed Port's operations, including the maneuvering of the LNGCs and support vessels. Both the NAA and the ATBA are normally recommendatory.

Delfin LNG does not propose to establish new aids to navigation or channel markers as part of the proposed Port per the provisions of 33 CFR 149.510. The water depth at the proposed Port location (64 to 72 ft) should be of sufficient depth for any LNGCs that could call on the proposed Port. Because LNGCs would not be constrained to specific channels, there would be no need to add buoys or other navigational aids to mark approach routes to the FLNGVs. In addition, all LNGCs would be equipped with Global Positioning Systems and radar that would enable the accuracy during approach of several meters.

LNGCs would be under the mandatory direction of a Delfin LNG Mooring Master and the mandatory assistance of tugboats during arrival and departure from the proposed Port. Both the Mooring Master and the LNGCs' navigation crew would maintain a visual lookout to assist in approach and departure from the proposed Port. Specific requirements for the Mooring Master as well as minimum visibility standards for arrival and departure would be specified in the Delfin LNG Port Operations Manual and maintenance provisions found in the FERC Plan and Delfin LNG's Procedures.

Obstruction lights, as required by 33 CFR 149.520 would be displayed on all four FLNGVs while moored at the proposed Port. When disconnected from the TYMS and under their own power, the FLNGVs would display lighting as required by vessels in navigation. The TYMS would also display the required obstruction lights and would be visible at night even when the FLNGV is disconnected.

Each FLNGV would independently display a radar beacon per regulations set forth in 33 CFR 149.580 as well as install and use the sounds signal as described in 33 CFR 149.585. The sound signal would serve as an audible warning to mariners at times of reduced visibility. Also, when connected to the TYMS, each FLNGV would display a rotating beacon as required in 33 CFR 149.535. Alternatively, the rotating beacon could be displayed on each of the TYMS; however, this would be determined during detailed design.

2.2.10.2 Delfin Onshore Facility

The proposed DOF would be operated and maintained in accordance with DOT regulations provided in 49 CFR Part 192, the FERC's guidance at 18 CFR Section 380.15, and maintenance provisions found in the FERC Plan and Delfin LNG's Procedures (see Appendix F).

2.2.11 Decommissioning

Decommissioning of the proposed Project would be performed when necessary or at the end of the useful life of the Project, which is an estimated 30 years and would take approximately 10 weeks to complete. Vessels and barges would be mobilized to remove the proposed Port components, which would be transported for recycling or disposal. Delfin LNG would prepare a decommissioning plan prior to decommissioning activities. The major tasks that would be associated with decommissioning include:

- disconnect the FLNGVs from the TYMS;
- mobilize a dive support vessel and jack-up liftboat;

- purge, clean, and flood the UTOS-HIOS pipelines, pipeline laterals, and risers;
- disconnect the UTOS and HIOS pipelines from the WC 167 bypass;
- cap and bury the end of UTOS at the WC 167 offshore manifold platform;
- disconnect tie-in spools connecting the pipeline laterals to the HIOS pipeline and TYMS;
- mobilize derrick barge to recover TYMS, risers, mooring buoys and chain, rope, and anchors;
- remove and transport TYMSs, risers, mooring buoys and chain, rope, and anchors to disposal or salvage facility;
- cap and bury both ends of pipeline laterals and tie-in spool;
- remove support vessel mooring anchors;
- cutting all bottom founded items such as driven pile and grouted pile anchors no shallower than 15 feet (approximately 5 meters) below mudline;
- clean up debris on seafloor and verify using a trawling contractor to ensure site clearance; and
- demobilize all vessels.

The FLNGVs, if not scheduled for a life extension, would be transported to a suitable facility for removal of LNG equipment that would either be used on another LNGC or salvaged for future use. The hull of the FLNGVs would be converted for use as another type of vessel until the end of its useful life when it would be recycled or salvaged.

The HIOS pipeline would be under a Pipeline Services Agreement with HIOS LLC. Therefore, when the proposed Project is decommissioned, the owner of the HIOS pipeline could enter into another agreement for use of the pipeline or seek to decommission the pipeline though the FERC's Section 7(b) process. For the UTOS pipeline and the WC 167 bypass, the following steps would be performed to abandon the pipeline per 30 CFR Section 250.1751:

- purge, clean, and flood the pipelines;
- disconnect the UTOS and HIOS pipelines from the WC 167 bypass;
- cap and bury the southern end of the WC 167 bypass at least 3 ft below the seafloor or cover the end with a concrete mat;
- disconnect the onshore portion of the UTOS pipeline from the compressor station and pig launcher piping;
- cap and bury the onshore portion of the UTOS pipeline at least 3 ft below ground level; and
- abandon in place.

The pipeline laterals would be abandoned through the same process above for the UTOS pipeline and WC 167 bypass with the exception that the tie-in spools would be disconnected, the pipeline laterals would be pigged, all subsea valves would be closed, and the ends of the pipeline laterals would be capped at both ends and buried with the tie-in spools at least 3 ft below the seafloor or covered with concrete mats.

The following steps would be performed for the decommissioning of the mooring systems:

- purge and clean all piping and equipment on the TYMS,
- close all valves,
- cap piping connections,
- remove the TYMS and transport via barge to onshore salvage or disposal facility,
- cut pilings approximately 15 ft below the seabed,

- remove TYMS jacket structure and riser for transport via barge to an onshore salvage or disposal facility,
- remove support vessel mooring anchors and transport via barge to onshore salvage or disposal facility, and
- clean up any debris on the seafloor.

Delfin LNG currently has no plans for future expansion or abandonment of the proposed DOF. If a decision is reached to expand or abandon the proposed DOF, Delfin LNG would seek all appropriate authorizations from Federal, State, and local agencies, including FERC abandonment authority for the onshore facilities under Section 7(b) of the Natural Gas Act.

2.2.12 Best Management Practices

Delfin LNG has committed to implementing best management practices (BMPs) to the extent practicable to minimize environmental and social impacts due to the construction, operation, and decommissioning of the proposed Project (see Appendix G). BMPs are discussed by resource in Section 4 and are based on Federal and State guidance documents and regulations well as standard practices associated with the industry and the proposed Project area. The impact conclusions made in Section 4 take these BMPs into account with regard to mitigation and minimization of potential impacts.

Federal and State agencies may provide similar or additional measures as the environmental review for this proposed Project progresses. These measures will be addressed in the final EIS.

2.3 Alternatives

The National Environmental Policy Act (NEPA) of 1969 requires that any Federal agency proposing a major action consider reasonable alternatives to the Proposed Action. Evaluation of alternatives assists in avoiding unnecessary impacts by analyzing reasonable options to achieve the underlying purpose that Delfin LNG may or may not have considered. This analysis of alternatives broadens the scope of options that might be available to reduce or avoid impacts associated with the action as proposed by Delfin LNG. The NEPA environmental analysis is one of the nine factors the Secretary must consider in making a final determination (33 U.S.C. 1503c). Alternatives for an LNG deepwater port may extend to matters such as its specific design, location, methods of construction, and technologies for liquefying, storing and loading LNG.

To warrant detailed evaluation by the USCG and the Maritime Administration (MARAD), an alternative must be reasonable and meet the purpose and need of the proposed Project. Alternatives concerning location, construction, and operation of a deepwater port for receipt and transfer of LNG must also meet essential technical, engineering, and economic threshold requirements to ensure that a proposed action is compliant with governing standards. Screening criteria are used to determine the feasibility of alternatives. The Secretary has identified that potential alternatives to deepwater ports, such as the proposed Project, may include alternative deepwater port designs, locations, technologies and operations, as well as the No Action Alternative.

Our evaluation of alternatives is presented in the following sections:

- Alternative Deepwater Port Designs (Section 2.3.1)
- Alternative LNG Liquefaction Technologies (Section 2.3.2)
- Alternative Cooling Media (Section 2.3.3)
- Alternative Pipeline Routes (Section 2.3.4)
- Alternative Port Locations (Section 2.3.5)
- Alternative Use of the Existing WC 167 Offshore Manifold Platform (Section 2.3.6)

- Alternative Mooring Systems (Section 2.3.7)
- Alternative Anchoring Methods (Section 2.3.8)
- Alternative DOF Locations (Section 2.3.9)
- No Action Alternative (Section 2.3.10)
- Energy Alternatives (Section 2.3.11)

The alternatives found to be reasonable and evaluated in this final EIS are provided in Table 2.3-1 and are based on the detailed discussion provided throughout Section 2.2.

Table 2.3-1. Summary of Alternatives Considered

Alternative Concept	Options/Locations	Evaluated in Detail in Section 4
Alternative Deepwater Port Designs	Gravity-based structure (GBS)	Yes
	Fixed platform-based unit	Yes
	Floating HiLoad port	Yes
	Floating LNG vessel (FLNGV)	Yes
Alternative LNG Liquefaction Technologies	Expander process	No
	Dual mixed refrigerant (DMR) process	No
	Single mixed refrigerant (SMR) process	No
Alternative Cooling Media	Open-loop, water-cooled system	Yes
	Air-cooled system	Yes
Alternative Pipeline Routes	High Island Offshore Systems, LLC (HIOS)/ U-T Offshore Systems, LLC (UTOS)	Yes
	Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC	Yes
	Columbia Gulf Transmission Company	No
	Kinetic Partners, LLC (western section)	No
	Sea Robin Pipeline Company, LLC	No
	Kinetica Partners, LLC (central section)	No
Alternative Port Locations	Alternative 1	Yes
	Alternative 2	Yes
	Alternative 3	Yes
Alternative Use of the Existing WC 167 Offshore Manifold		No
Alternative Mooring Systems	Permanent mooring system	Yes
	Disconnectable mooring system	Yes
Alternative Anchoring Methods	Suction anchor	Yes
	Driven piles	Yes
	Fluke anchors	Yes
	Gravity-based anchors	Yes
	Grouted pile anchors	Yes
Alternative DOF Locations	Alternative #1	Yes
	Alternative #2	Yes
	Alternative #3	Yes
	Alternative #4	Yes
No Action Alternative		Yes
Energy Alternatives	Fuel oil, coal, nuclear, and renewable energy	No

2.3.1 Alternative Deepwater Port Designs

Selection of the optimal deepwater port design depends on the consideration of multiple environmental, technical, and commercial factors. Four specific environmental and technical considerations were evaluated in this analysis including:

- air emissions;
- general environmental effects;
- visual impacts; and
- water depth and seafloor topography.

Four different deepwater port designs were considered in the alternatives analysis for the proposed Project. All of the design concepts would require the construction of a pipeline to deliver the natural gas to the target market. The designs considered included: (1) a gravity-based structure (GBS); (2) a fixed platform-based unit; (3) a floating HiLoad port design; and (4) a floating LNG vessel (or FLNGV).

Each of the concept designs was evaluated as an alternative to the proposed Project to determine whether it would be reasonable and environmentally preferable. Although each of these concepts has some adaptability of design, each also has some inherent features that are most compatible with certain environmental conditions and that lend themselves to specific business models. Each of the alternative concept designs was evaluated based on its suitability for use in the Gulf of Mexico, as well as its economic and operational feasibility.

Table 2.3-2 provides an environmental evaluation summary for each of the proposed deepwater port design alternatives based on the specific environmental and technical considerations evaluated in the analysis of the deepwater port design alternatives.

Table 2.3-2. Environmental Evaluation of the Proposed Deepwater Port Design Alternatives a/

Category	Topic	Fixed Platform-Based Unit	Floating LNG Vessel (FLNGV)
Environmental	Air Emissions b/	Similar to proposed Project.	Mobile emissions would include related ship maneuvers and tugs that would be required during construction and operation.
	Water Intake and Discharge	Likely requires a greater level of water intake and discharge than the proposed Project	Closed loop cooling media would result in minimal water intake and charge.
	Turbidity/ Sedimentation	None during operations due to no seafloor disturbance.	Moderate if anchor-based mooring system is used due to chain sweeps. Minor if the mooring tower or similar fixed structure is used (would eliminate chain sweeps).
	Sea Floor Removal – Benthic Habitat Loss (Permanent Structures)	Minimal sea floor conversion.	Minimal sea floor conversion.
	Fisheries Impacts	May serve as a fish attractor.	Minimal seafloor disturbance and footprint would result in minimal impacts on fisheries.
	Visual Resources	Designed with lower deck above height of largest expected wave in 100-year storm; would stand taller than a floating design.	Likely be unseen from most onshore vantage points but would have minimal offshore impacts with constant, fixed, above surface structures.
	Shallow Water Impacts	Similar to the proposed Project.	Minimal impacts on seabed.

Table 2.3-2. Environmental Evaluation of the Proposed Deepwater Port Design Alternatives a/ (continued)

Category	Topic	Fixed Platform-Based Unit	Floating LNG Vessel (FLNGV)
Technical Considerations	Depth (feet)	Better suited in water depth limit of 200-300 feet.	Independent of water depth.
	Storage and Liquefaction Systems	Possible permanent facilities.	Permanent facilities.
	Seafloor topography considerations	No	No
Supply	Continuous or intermittent supply	Generally capable of a continuous supply; possibly constrained by storage capacity weather related supply interruption, and/or LNG availability.	Generally capable of a continuous supply; possibly constrained by storage capacity, weather related supply interruption, and/or LNG availability.
Operational Availability	Downtime during storm events	High potential due to mooring issues.	Self-propelled vessel with its own population system, which allows the FLNGVs to disconnect and depart when threatened by severe storms

Notes:
a/ Only port designs that are carried forward in the analysis are included in this table.
b/ Will depend on the actual system used (e.g., vaporization system, recycling systems).

Gravity-Based Structure

The GBS would be composed of two pre-stressed reinforced concrete caissons that would be constructed at a graving dock, which is a specialized inshore construction facility with adjacent channel depths sufficient to float the completed structure. Graving dock land requirements and environmental impacts would vary from site to site, but could typically range between 50 to 100 acres.

The concrete structure would be floated to the site and installed to the seabed. All facilities associated with a typical LNG export terminal (storage tanks, loading arms, accommodations, and liquefaction equipment) would be attached to the concrete structure. Because the GBS must extend above the water surface but still enable access by LNGCs, these designs are typically constrained to relatively shallow waters, typically 45 to 85 ft in depth. The depth required for the skirt depends on the hard strata depth for the foundation. There are methods that could be utilized to stabilize the soils beneath the GBS such as overburden removal or soil mixing; however, each method would increase construction costs. In addition to the siting requirements and operational and environmental tradeoffs, economic feasibility must be considered. There are significant capital costs associated with GBS construction and installation. In the past, five LNG deepwater port applicants proposed these structures with two being approved by MARAD, but none were built.

Due to the large graving dock land requirements needed to construct the GBS and the large amount of seafloor impacts associated with the pad (approximately 460,000 square feet [ft^2] or 10.5 acres), it is not considered a feasible alternative and has therefore been eliminated from further discussion.

Fixed Platform-Based Unit

A fixed platform-based unit would consist of constructing or re-purposing an offshore unit, which is either an active or decommissioned Gulf of Mexico facility. The offshore unit would be attached to the seabed by multiple legs or a jacket structure with a working platform above the water. Docking facilities, LNG loading arms, storage tanks, liquefaction equipment, and accommodations would be installed on the platform.

These types of structures have been installed in water depths up to 1,400 ft and design specifications indicate that they could be installed in water depths up to 3,000 ft; however, a water depth limit of 100 to

300 ft is more practical for this design. According to the Main Pass Energy Hub Final EIS (USCG and MARAD 2006b), the siting plot requirements for this type of unit could range from 20,000 ft^2 to 32,100 ft^2. Two past LNG deepwater port applicants (Clearwater Port and Main Pass Energy Hub) proposed this type of port design, but neither were ever built.

Floating HiLoad Port

The floating HiLoad port design utilizes an open-loop vaporization system that operates below the water line of a floating platform. Because the HiLoad port design is a floating unit, its impact on the seafloor is minimal, consisting only of a conventional anchoring system. Additionally, the HiLoad anchoring system would not require specific seafloor characteristics and qualities. However, HiLoad port design tests under varying sea states have shown that depths of 200 to 500 ft are optimal. One past LNG deepwater port applicant proposed this type of port design. It was approved by MARAD but was never built. Recently, Teekay Corporation's *Navion Anglia* commenced sea passage to Las Palmas with their HiLoad Dynamic Positioning No. 1 docked on its port side. This is currently the only commercially used HiLoad unit to date; all other HiLoad uses have been at the testing level. Currently, the floating HiLoad port design is purposed for regasifying LNG for import and has not been designed for the purpose of liquefying LNG for export. Therefore, this alternative has been eliminated from consideration.

Floating LNG Vessel (FLNGV)

An FLNGV is a self-propelled vessel that is moored to a TYMS that allows the vessel to weathervane. The FLNGV is self-propelled to allow it to disconnect and depart under its own power should severe weather be encountered or if repairs or drydocking is required. FLNGVs are designed to take natural gas from an existing pipeline system, liquefy the gas, and transfer the LNG to a LNG carrier. FLNGVs can also be designed to include storage of LNG and accommodations for personnel. The FLNGV concept allows for greater flexibility in siting because it is a vessel, with its only constraint being the mooring system. Because the FLNGV is a vessel, it is independent of water depth, providing the clearance for the vessel draft is met. The optimum water depth would therefore be based on the mooring system, which in this case is 60 to 120 ft for the TYMS. Though the components of the FLNGV are all proven technologies, this specific concept vessel has not been commissioned in the U.S, though several similar concepts have been proposed.

2.3.1.1 Alternative Deepwater Port Design Evaluation

General Environmental Effects

General environmental effects can include impacts from water use and discharges, turbidity and sedimentation, as well as seafloor and fisheries impacts. Water usage would be dependent on the type of specific systems that would be selected for each alternative, as well as the number and type of support vessels required for operations. Installing large structures on the seafloor would have direct impacts on the seafloor as well as recreational and commercial fisheries resources. On the other hand, fixed platform-based units, and the TYMS for the FLNGV concept, can create new habitat through the development of hard substrate at different depths and artificial reefs.

Visual Impacts

In general, the two deepwater port design alternatives would have minor visual impacts due to their distance from onshore receptors. The fixed platform-based structure would need to be designed so that the lower deck would be at a higher elevation than the wave heights associated with the largest typical storm event. The FLNGV would resemble large vessels on the horizon, similar to the existing visual landscape. Similarly, fixed platform-based structures are part of the offshore viewshed in the Gulf of Mexico and therefore would be more innocuous to onshore visual receptors.

Water Depth and Seafloor Topography

Platform-based units have constraints regarding the avoidance of geologic hazard areas. Conversely, the FLNGV concept allows for alternative anchoring methods based on the substrate type.

Safety

The fixed platform-based unit is a stationary structure in the water. All liquefaction and storage equipment would be located on the platform similar to a traditional land-based LNG facility. The FLNGV concept allows for the FLNGV to depart the TYMS during severe storm events. At the first sign of significant weather, the Port Manager and LNGV Master would determine the Master's needs and plans for storm evasion, such that any order to evacuate would be done in a manner timely enough to allow safe weather evasion.

2.3.1.2 Alternative Deepwater Port Design Conclusions

As stated above, the GBS design is not considered a feasible alternative due to the large graving dock land requirements and the large amount of seafloor impacts associated with this design. The floating HiLoad port design is also not considered a feasible alternative because it has not been designed for the purpose of liquefying LNG for export.

A fixed platform-based unit would likely result in additional seafloor impacts due to foundation requirements for the truss-type structure. The fixed platform-based unit also has minor siting limitations in regards to geologic hazards and is more practical for use in water depths greater than 200 ft.

The FLNGV concept has design flexibility that allows it to be sited in various substrate conditions and would result in fewer impacts on the seafloor than other designs. Also, the FLNGV would be able to leave the deepwater port under its own power in severe weather conditions.

Because the FLNGV and fixed platform-based designs would meet the proposed Project purpose and need, is a proven technology, and meets environmental, engineering feasibility, and reliability criteria, these designs are considered to be a reasonable alternative and have been carried forward for detailed analysis in this final EIS.

2.3.2 Alternative LNG Liquefaction Technologies

Three LNG liquefaction technologies are available for the FLNGV design: expander process, dual mixed refrigerant (DMR) process, and single mixed refrigerant (SMR) process.

The expander-based process utilizes nitrogen (N_2) as the refrigerant. This process is suitable for small LNG production facilities. The refrigeration is derived from sensible heat transfer. The system is simple to operate and insensitive to motion because of single vapor phase. Vapor phase densities are low which result in lower heat capacities as compared to latent heat of boiling liquids used in the SMR or DMR technologies.

The DMR process is more complex than the SMR process because it has two mixed refrigerant (MR) cycles. As a result, there generally are two compressor strings. One is used for warm MR and the other for cold MR. It also has two coil-wound heat exchangers. It is typically used for higher capacity LNG facilities because of higher efficiency.

The SMR process is typically used for medium-capacity LNG facilities. Attributes of SMR technology are reduced equipment inventory, simple to operate, and medium to high efficiency. It uses hydrocarbons for the refrigerant which result in somewhat higher flammable inventory than N_2 expander processes; however, it is efficient and safe to operate.

The SMR technology was selected because it provides a balance between simplicity and efficiency for the nominal output of each FLNGV.

2.3.3 Alternative Cooling Media

For LNG liquefaction facilities, two types of cooling media can be employed: open-loop, water-cooled heat exchangers or air-cooled heat exchangers.

An open-loop, water-cooled system uses a "once-through" system that requires a substantial amount of seawater for the cooling process. Depending on the temperature differential of seawater, each FLNGV could use up to 201,905 gallons per minute or 807,620 gallons per minute for all four FLNGVs. The high water use could result in both impingement and entrainment mortality of aquatic organisms. In addition, temperature rise at the point of discharge could result in additional impacts on marine life. Open-loop, water-cooled systems also require the use of a biocide to protect the seawater piping from biological growth.

The air-cooled system is less efficient and does require more space on the FLNGV. As a result, the air-cooled system is more expensive. Also, since air is used for cooling, the air-cooled system would result in additional air emissions. However, the air-cooled system would result in negligible impacts on marine life. In addition, the air-cooled system would not require a cooling medium, such as glycol and freshwater mix, to be stored onboard the FLNGV, which would preclude the consideration of freshwater cooling towers, thereby offsetting the additional space required on the FLNGV.

Delfin LNG is proposing use of the air-cooled system as the cooling media; however, both cooling media alternatives are carried through for analysis of impacts by resource in Section 4.

2.3.4 Alternative Pipeline Routes

Certain criteria were analyzed to assess the viability of pipeline routes. The first criterion was to identify existing pipeline systems that are 36 inches in diameter or larger. Once existing infrastructure that met the 36-inch-diameter criterion was identified, several other criteria were applied to the pipeline routes. The criteria included the pipeline traversing water depths suitable for the construction and operation of a deepwater port of this design, being within 2 to 8 miles of a designated shipping safety fairway to allow for the transit of LNGCs, and avoiding other areas that may preclude the construction and operation of a deepwater port (e.g., National Marine Sanctuaries, USCG Lightering Areas, anchorage areas, etc.). In addition, the existing pipeline infrastructure had to have the capacity available to transport the required amount of natural gas to the FLNGVs.

Application of these criteria, including Delfin LNG's requirement of being within 150 miles of Henry Hub, resulted in six existing pipeline systems that met the criteria. The proposed pipeline route alternatives considered are shown on Figure 2.3-1 and are as follows:

- High Island Offshore Systems, LLC (HIOS)/U-T Offshore Systems, LLC (UTOS);
- Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC;
- Columbia Gulf Transmission Company;
- Kinetica Partners, LLC (western section);
- Sea Robin Pipeline Company, LLC; and
- Kinetica Partners, LLC (central section).

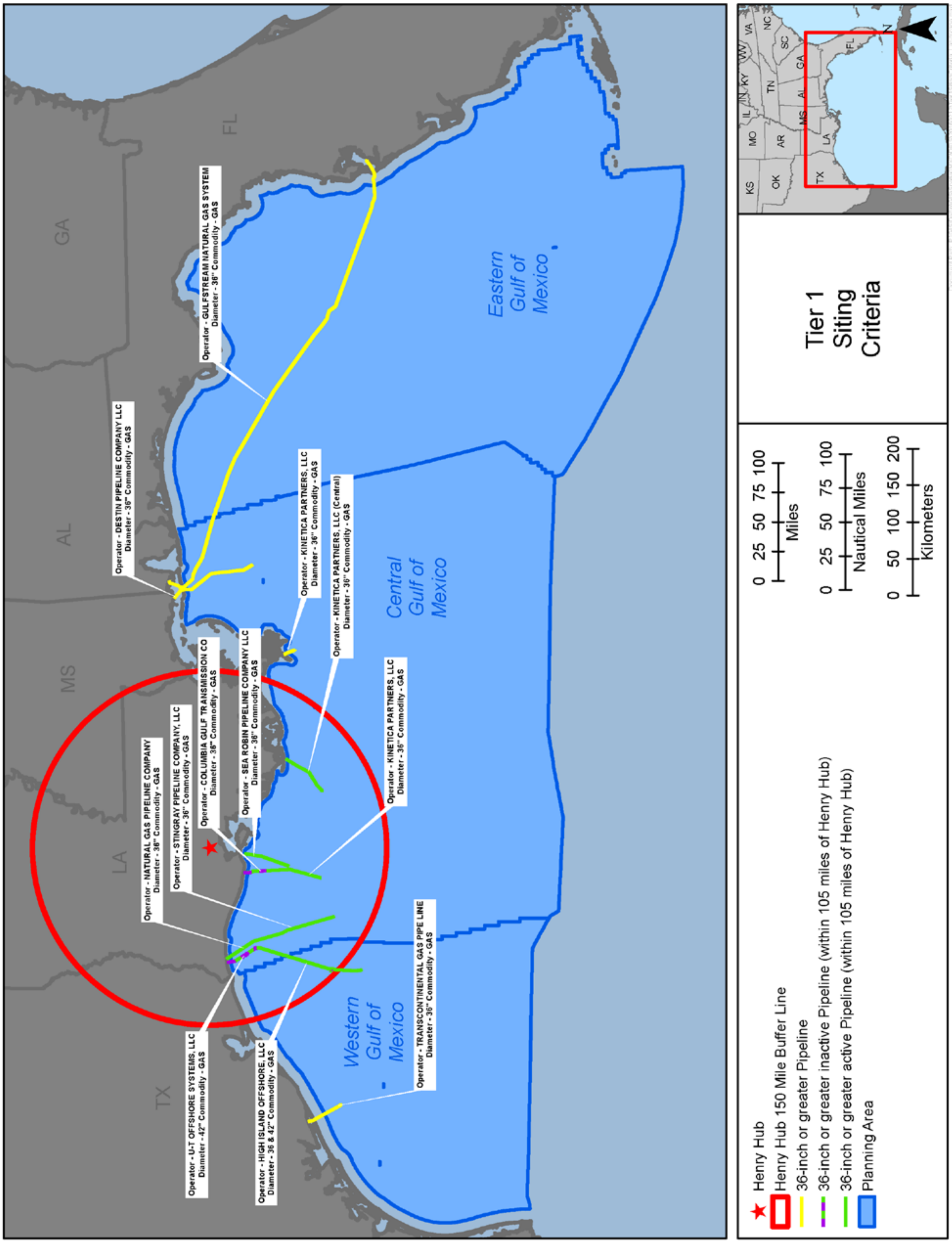


Figure 2.3-1. Tier 1 Siting Criteria

One of the criteria analyzed for the alternative pipeline routes was proximity to designated shipping safety fairways (per 33 CFR 166.200). It was determined that a distance of 2 to 8 miles from designated shipping safety fairways was required for the safe operation of supporting marine operations at the proposed Project. Close proximity to designated shipping safety fairways would also allow for the safe transit of LNGCs to and from the proposed Project. In addition to being close enough to a designated shipping fairway for the safe operation of support vessels, pipeline routes were evaluated for proposed Project locations that also would not otherwise impede or interfere with other commercial shipping operations. Based on this analysis, only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC met the criteria for proximity to maritime shipping fairways. All other existing pipelines are over 50 miles from the nearest maritime shipping fairway. Therefore, only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis.

2.3.4.1 Capacity

The HIOS system is currently underutilized, and has sufficient available capacity to support the proposed Project. The UTOS system is currently not in use, but meets the sizing specifications necessary for the proposed Project. The Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system currently transports gas produced in the Gulf of Mexico to Louisiana and could have the necessary capacity for the proposed Project. However, the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system is a smaller diameter pipe and could not therefore flow as much gas as the HIOS system. In addition, Delfin LNG has not conducted necessary business, legal, and regulatory efforts regarding the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC. The Secretary respects an applicant's expertise to identify those LNG deepwater port locations/facilities that represent viable business opportunities and relies on applicants to present reasonable and objective consideration of alternative locations to support their license applications. However, because this facility meets the siting criteria for pipeline facilities feasible for the Project design, it was carried through for analysis in this final EIS.

2.3.4.2 Alternative Pipeline Route Conclusions

Six existing 36-inch-diameter pipelines with the potential to transport natural gas from shore to the proposed Project were analyzed. Of the six pipelines analyzed, only two met the siting criteria for the proposed Project. The two existing systems that met the proposed Project siting criteria, HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC are both at least existing 36-inch-diameter pipelines and meet the criteria of being within 2 to 8 miles of a maritime shipping fairway without impeding or interfering with commercial shipping operations. Both systems are existing and would therefore have negligible impacts. However, the HIOS/UTOS pipeline would require the construction of a 700-ft greenfield bypass whereas the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC pipeline would not require any greenfield construction. Though there would be additional impacts associated with the HIOS/UTOS pipeline system as compared to the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system, those impacts would be minor and would not result in the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system having a considerable environmental advantage over the HIOS/UTOS pipeline system. Therefore, both pipeline systems have been carried forward in this analysis.

2.3.5 Alternative Port Locations

2.3.5.1 Siting Considerations

In identifying a potential site for a LNG deepwater port terminal, applicable USCG siting guidelines (33 CFR 148.720) must be considered. These guidelines indicate that an appropriate site for a deepwater port:

- optimizes location to prevent or minimize detrimental environmental effects;
- minimizes the space needed for safe and efficient operation;

- locates offshore components in areas with stable seafloor characteristics;
- locates onshore components where stable foundations can be developed;
- minimizes the potential for interference with its safe operation from existing offshore structures and activities;
- minimizes the danger posed to safe navigation by surrounding water depths and currents;
- avoids extensive dredging or removal of natural obstacles such as reefs;
- minimizes the danger to the port, its components, and tankers calling at the port from storms, earthquakes, or other natural hazards;
- maximizes the permitted use of existing work areas, facilities, and access routes;
- minimizes the environmental impact of temporary work areas, facilities, and access routes;
- maximizes the distance between the port and its components and critical habitats, including commercial and sport fisheries, threatened and endangered species habitats, wetlands, floodplains, coastal resources, marine management areas, and essential fish habitats;
- minimizes the displacement of existing and potential mining, oil, or gas production or transportation uses;
- takes advantage of areas already allocated for similar use, without overusing such areas;
- avoids permanent interference with natural processes or features that are important to natural currents and wave patterns; and
- avoids dredging in areas where sediments contain high levels of heavy metals, biocides, oil or other pollutants or hazardous materials, and in areas designated as wetlands or other protected coastal resources.

For Delfin LNG, one major circumstance prompted siting of the proposed Project. The Applicant required that the proposed Project location be able to utilize existing pipeline infrastructure (Figure 2.3-2). The existing pipeline infrastructure had to be within 2 to 8 miles of a maritime shipping fairway and have the capacity to transport the required amount of natural gas to the proposed Project. As discussed above in Section 2.3.4, two pipeline systems met these criteria: the HIOS/UTOS pipeline system and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system.

The evaluation of alternative deepwater port locations used a screening and site selection process that considered several factors. The selection included the port's proximity to existing pipeline infrastructure, shipping lanes, water depth requirements, the size requirement of 16 square miles, proximity to anchorage areas, and proximity to sensitive environmental resources. These requirements resulted in three potential alternative sites:

- Alternative 1 – along the HIOS/UTOS pipeline system within the BOEM-defined West Cameron Area, West Addition Protraction Area (Figure 2.3-3);
- Alternative 2 – along the HIOS/UTOS pipeline system within deeper waters of the BOEM-defined West Cameron Area, West Addition Protraction Area approximately 10 nautical miles south-southwest of Alternative 1 (Figure 2.3-3); and
- Alternative 3 – along the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system within deeper waters of the BOEM-defined West Cameron Area, West Addition Protraction Area approximately 27 nautical miles east of Alternative 2 (Figure 2.3-4).

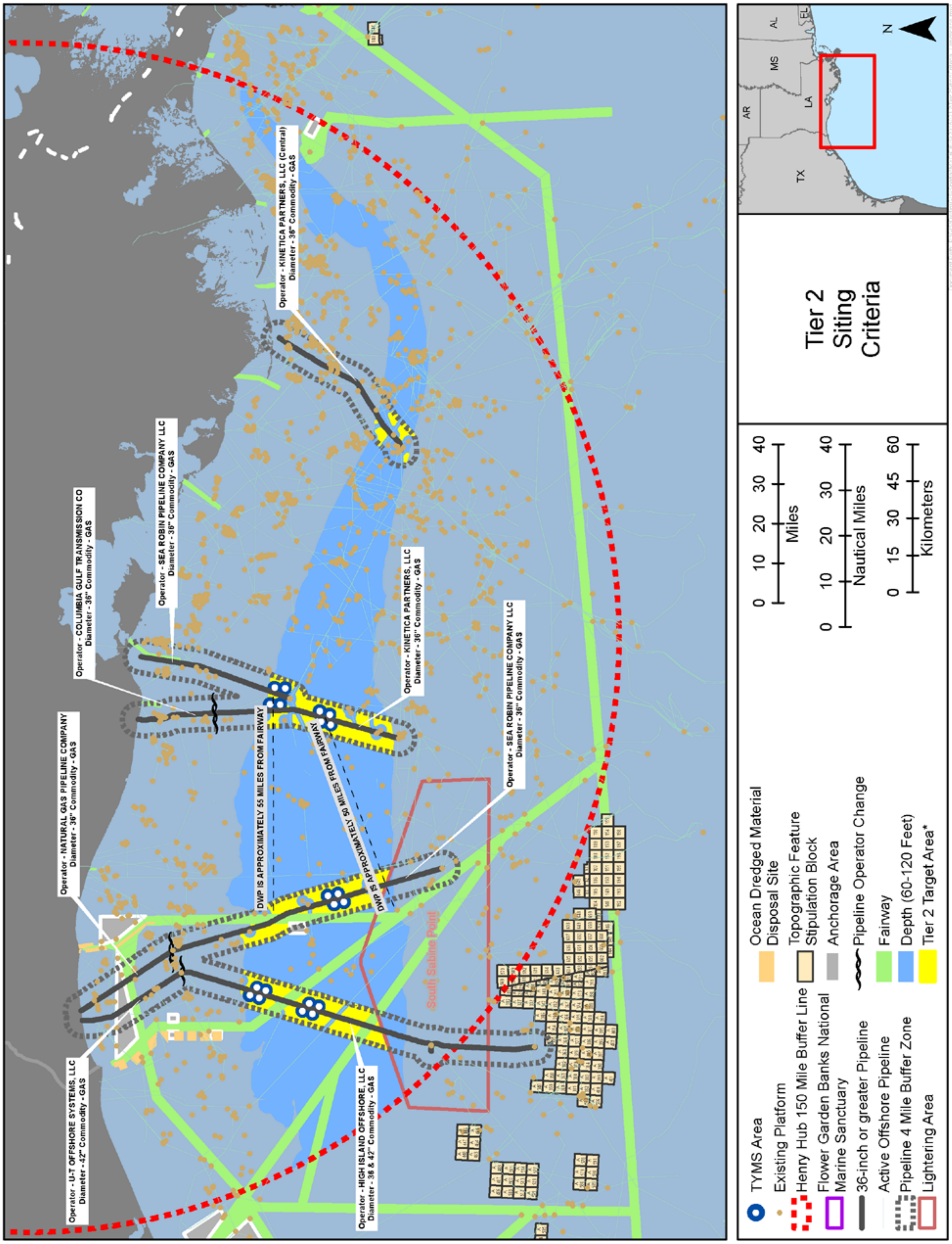


Figure 2.3-2. Tier 2 Siting Criteria

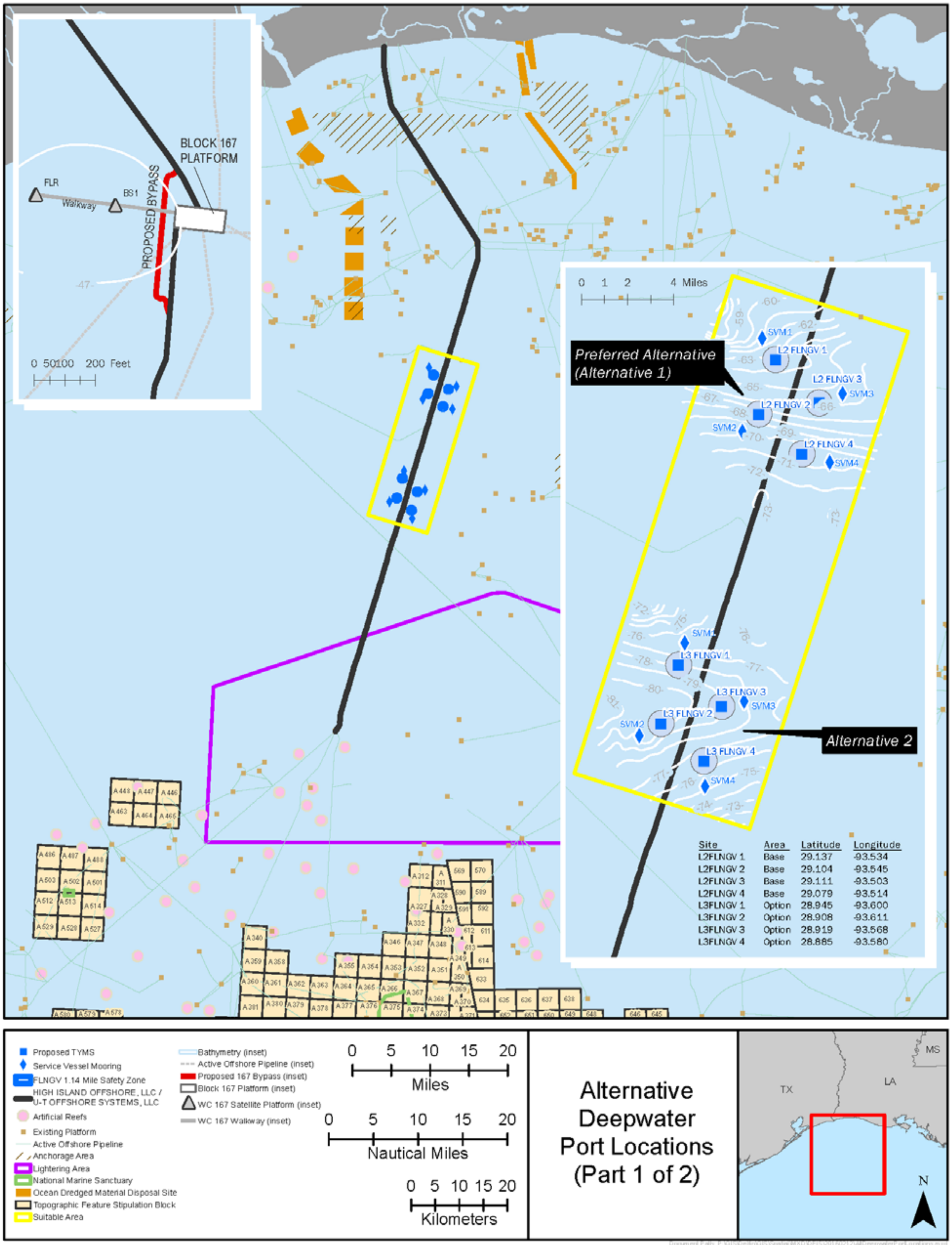


Figure 2.3-3. Alternative Deepwater Port Locations (Part 1 of 2)

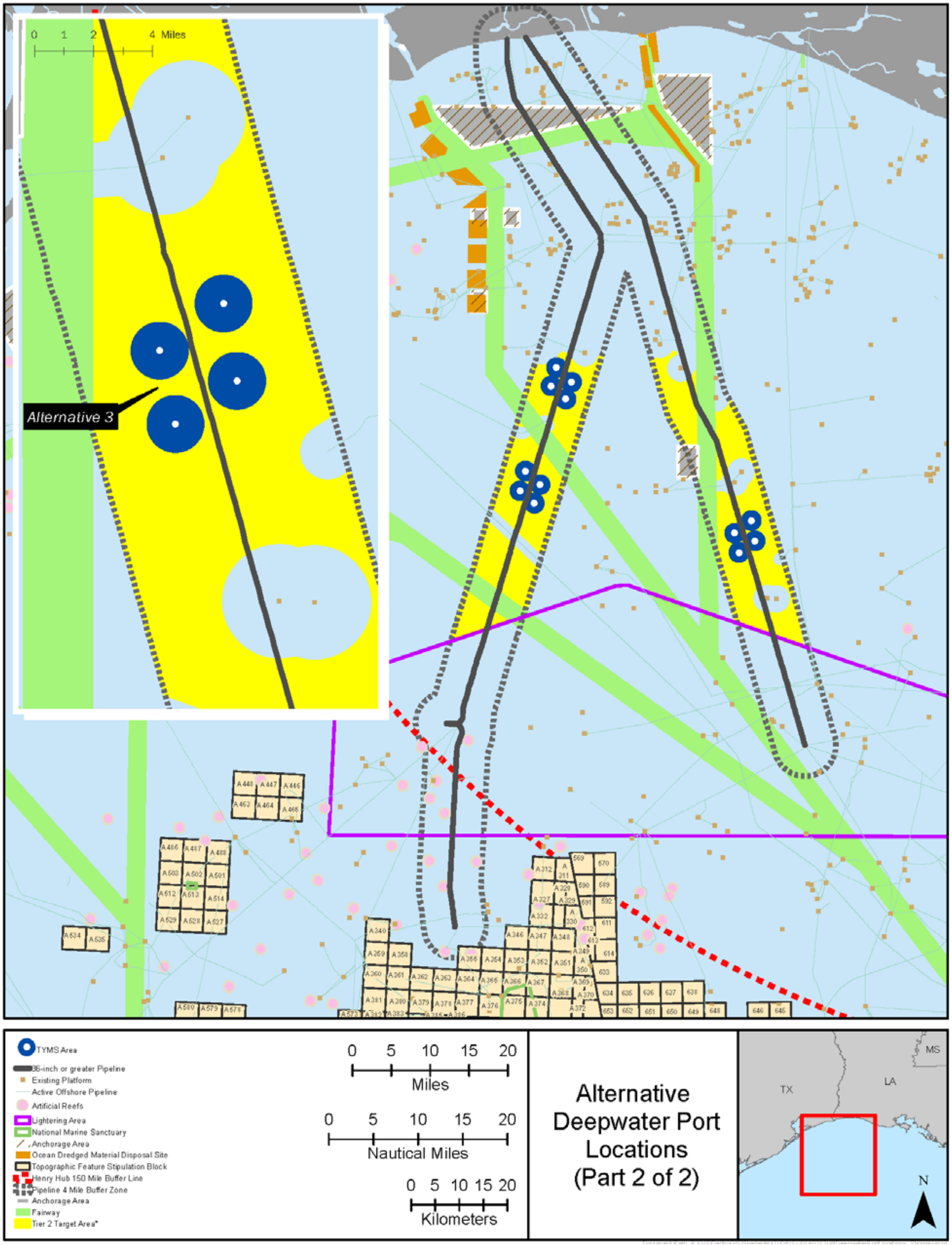


Figure 2.3-4. Alternative Deepwater Port Locations (Part 2 of 2)

These three alternative sites (Figures 2.3-3 and 2.3-4) were further evaluated based on avoidance of cultural resources, engineering, avoidance of geologic hazards, air emissions and noise, water and sediment quality, commercial and recreational fishing, wildlife and protected species, socioeconomics, and marine uses and aesthetics. There would be no differences in engineering, construction procedures or duration for any of the alternatives; although use of Alternative 3 on the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would avoid the need for the 700-ft greenfield pipeline construction associated with the WC 167 bypass. As discussed in Section 2.3.4.1, the existing Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC pipeline is not a commercially viable and necessary business; legal and regulatory efforts have therefore not been undertaken by the Applicant, and thus would not be feasible for the proposed Project. Therefore, no environmental data for Alternative 3 are available for comparison as it would not be viable without use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC pipeline. However, as discussed in Section 2.3.4.1, it has been carried forward for analysis in this final EIS because it meets the siting criteria. Due to the close proximity to the Alternative 1 and 2 locations, it is assumed that conditions and therefore impacts on the resources below, with the exception of cultural resources, would be similar to those for Alternatives 1 and 2.

Avoidance of Cultural Resources

In close proximity to all locations are maritime shipping fairways, oil and gas wells, and pipeline infrastructure. The Applicant conducted a cultural resources assessment of remote-sensing data and it was determined that neither Alternative 1 nor Alternative 2 are within 1,000 ft of potentially significant cultural resources in accordance with BOEM guidelines, NTL No. 2005-G07). Surveys were not conducted to determine the potential for cultural resources in proximity to Alternative 3.

Engineering

There would be no differences in construction duration or procedures between any of the alternative locations. Each location would be engineered the same utilizing the same equipment.

Avoidance of Geologic Hazards

Both Alternative 1 and Alternative 2 contained localized normal faults; however, none of the faults exhibited seafloor displacement that would preclude siting, construction and operation of the proposed Project. A single mooring for the proposed Project and an associated service vessel mooring at Alternative 2 were located over a subsurface salt diapir. These locations would require additional evaluation of potential geophysical hazards. It is likely because of the proximity of Alternative 3 to these locations that geologic hazards would be comparable, though additional geophysical hazard analysis would need to be completed for Alternative 3 to determine specific hazards at this site.

Air Emissions and Noise

Engineering at each of the alternative locations would be the same. Therefore, it could be expected that air emissions and noise from construction of the proposed Project and operation of the FLNGVs would be the same for all locations. Because Alternatives 2 and 3 are 10 to 15 nautical miles farther offshore from Alternative 1, it is likely that additional compression would be required at the proposed compressor station. Additional compression would result in additional noise and additional air emissions.

Water and Sediment Quality

Construction equipment and duration would be the same for each of the alternative locations. However, Alternative 3 would be located in waters that average a depth of about 80 ft, and Alternative 2 would be located in waters that average a depth of about 73 ft versus Alternative 1 that averages about 66 ft. This additional depth could result in increased turbidity and sediment transport from anchor chain movements as a result of the greater sweep area.

Commercial and Recreational Fishing

Each alternative would result in the same proposed safety zone of 2,612 acres that would restrict use of the area by fishermen. It is unknown whether any of the alternative locations contain preferred fishing grounds to the other or vice versa. Therefore, impacts on commercial and recreational fishing would be the same for all of the alternative locations.

Wildlife and Protected Species

The increased depth at Alternatives 2 and 3 could require longer piles and additional pile-driving durations. This could result in additional noise impacts on fish, marine mammals, and sea turtles in the vicinity of construction activities.

Socioeconomics

The increased distance of 10 to 15 nautical miles from shore of Alternatives 2 and 3 as compared to Alternative 1 could result in additional fuel, maintenance, and operational costs that could result in slightly greater economic benefits.

Marine Uses and Aesthetics

All alternative locations would be far enough from shore to reduce visual impacts, a comparable distance from the closest maritime safety fairway, and none of the locations are in a Military Warning Area. Though the closest oil and gas platform for Alternative 1 (4.1 miles) and Alternative 3 (5.4 miles) is closer than the closest platform for Alternative 2 (7.1 miles), the platforms are unmanned, meaning there is limited transit of support vessels and traffic to and from the platforms. In addition, neither alternative location contains an active OCS lease block within 5 miles. Therefore, impacts on marine uses and aesthetics would be similar at both Alternative 1 and Alternative 2.

2.3.5.2 Deepwater Port Location Alternatives Conclusions

Neither alternative location would have significant impacts on resources in their respective vicinities. However, Alternatives 2 and 3 would require further assessment of geophysical hazards, are 10 to 15 nautical miles farther from shore, respectively, which could require additional service trips as well as additional compression at the proposed DOF resulting in greater noise and air emissions, and are located in deeper waters which could result in longer piles resulting in more noise impacts on marine species.

2.3.6 Alternative Use of the Existing WC 167 Offshore Manifold Platform

The Secretary respects an applicant's expertise to identify those LNG deepwater port locations that represent viable business opportunities and relies on applicants to present reasonable and objective consideration of alternative locations to support their license applications. Reuse of the WC 167 platform would result in the interaction with six other pipeline systems currently utilizing the platform, require the removal and replacement of UTOS facilities and potential increased compression as a result of less efficient hydraulics.

The Applicant proposes to bypass the WC 167 offshore manifold platform and avoid any potential impacts described above. The bypass would impact approximately 700 ft of seafloor as a result of the new trench being dug for the bypass pipeline; however, these impacts would be considered negligible compared to the potential impacts from repurposing the WC 167 offshore manifold platform. No other bypass alternatives were considered or eliminated in this analysis, and alternative use of the existing WC 167 offshore manifold platform is not carried through in this final EIS.

There are no bypass pipelines that would be associated with the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC pipeline system and therefore this analysis is not required for the alternative.

2.3.7 Alternative Mooring Systems

There were two types of mooring systems considered for the proposed Project: permanent and disconnectable mooring systems. The main design criteria of the mooring system is to provide a stable environment for FLNGV operations.

2.3.7.1 Permanent Mooring System

A permanent mooring system would allow the FLNGV to stay moored at the deepwater port during all weather conditions. This would also preclude the need for the FLNGV to be self-propelled. A permanent mooring system at the location of the deepwater port with associated meteorological and oceanographic conditions would require additional design beyond what is currently available as a proven technology.

2.3.7.2 Disconnectable Mooring System

A disconnectable mooring system allows for greater flexibility for the FLNGV while at the deepwater port. The disconnectable mooring system allows the self-propelled FLNGV to depart from the deepwater port in severe storm conditions or if maintenance were required. In addition, the size of the anchoring system for the disconnectable mooring system can be designed much smaller than that of a permanent mooring system which would need to safely anchor the FLNGV during extreme ocean conditions.

2.3.8 Alternative Anchoring Methods

Installation of the TYMS mooring structure would require an anchoring mechanism to attach the structure to the seafloor.

Selection of the optimal anchor design depends on the consideration of multiple environmental and technical factors. Seven environmental and technical considerations were evaluated in this analysis including:

- air emissions;
- water use and discharge;
- turbidity, sedimentation, and seafloor impacts;
- fisheries impacts;
- noise impacts; and
- decommissioning impacts.

2.3.8.1 Alternative Anchoring Methods

Five different anchor designs were considered. The design alternatives included: (1) suction anchors; (2) driven piles; (3) fluke anchors; (4) gravity-based anchors; and (5) grouted pile anchors.

Suction Anchors

A suction anchor consists of a high-grade steel caisson or “upside down bucket”. The suction anchor would be embedded in the sediments by pumping out water and creating a negative pressure inside the caisson skirt. Suction anchors are best used in clay and fine sediment conditions with few sediment layers, and have proven highly reliable. Installation of suction anchors is sensitive to water depth as the installation relies upon the section pressure being built up within the anchor and the pressure of the given water column above to overcome the resistance in the sediment. Additionally, the potential lack of soil penetration could result in limitations in restraining the TYMS from overturning moments. Suction piles are recoverable during decommissioning.

Driven Piles

A driven pile consists of a high-grade steel pile with an outer diameter of 78 inches and a pile length of 300 ft. Driven piles are generally used in conditions consisting of non-cohesive sediments, such as sand or silt, or in stratified soil conditions but can be effective in most soil conditions. Driven pile installation is not sensitive to water depth because a steam or hydraulic hammer would drive the pile down to the target depth. Driven piles would be an effective means of securing the TYMS to the seafloor and have the ability to restrain the TYMS from large overturning moments. Decommissioning of driven piles typically involves cutting the pile about 15 ft below the seafloor and leaving the remainder of the pile in place.

Embedded Anchors (Fluke Anchors)

Fluke anchors are typically steel structure with some sort of anchor referred to as a hook or fluke. They derive a significant portion of their holding power from hooking or embedding in the bottom, with a secondary reliance on their mass, and can be used in a wide range of soil types. Installation involves dragging an anchor with heavy pull service vessels to embed them in the soil. Where fluke anchors are used, special attention must be paid to anchor positioning and tensioning. When used in soft sediments, these anchors are dragged down into the sediments and their holding capacity is dependent upon the subsequent level of tensioning. Fluke anchors have limitations in restraining the TYMS from large overturning moments. During decommissioning, fluke anchors are recoverable.

Gravity-Based Anchors

Gravity-based anchors use large masses, commonly a block or slab of reinforced concrete resting on the seabed. Smaller anchors may be lowered into the seabed by jetting so they are flush with or just below the surface. Gravity-based anchors would not be an effective engineering solution for securing the TYMS to the seafloor due to limitations in being able restrain the TYMS from large overturning moments. This anchoring method would be easily recoverable during decommissioning.

Grouted Pile Anchors

Grouted piles are similar to driven piles, but installed differently. If the sediment condition consists of cemented soil layers and/or rock material, grouted piles may be required, as these materials limit the amount of penetration with driving hammers. A hole for the pile would be drilled into the seafloor to achieve the penetration of the grouted pile anchor. Grout is then pumped in between the soil/cemented wall and the pile. Grouted pile anchors are not easily recovered during decommissioning and the general practice is similar to driven piles where they are cut 15 ft below the seafloor.

2.3.8.2 Impacts from Alternative Anchoring Methods

Air Emissions

Air emissions would vary only slightly for each alternative, mostly attributable to the number and type of support vessels used. Pile or fluke anchors would result in less air emissions due to the decreased number of required ship transits during construction. For gravity-based anchors, the impacts of transportation and placement of multiple oversized gravity-based anchors from onshore facilities to the proposed Project area would result in the greatest impact from air emissions for the alternatives considered in this analysis.

Water Use and Discharge

As with air emissions, water use and discharge would vary only slightly for each alternative, mostly attributable to the number of support vessels required for construction. Installation of suction, pile, or fluke anchors would result in lower water use and discharge than installation of the gravity-based anchor due to the decreased number of required ship transits during construction.

Turbidity, Sedimentation, and Seafloor Impacts

During installation, all anchor alternatives would have short-term turbidity and sedimentation impacts. These impacts would be limited to the duration of installation. It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in significantly less of an effect on benthic habitat. Installation of a gravity-based anchor would result in the greatest disturbance due to a larger footprint, followed by the fluke anchor system, which would result in disturbance due to the necessary pulling of the anchor in the seafloor.

Fisheries Impacts

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in significantly less of an effect on fisheries. Suction anchors, by virtue of pumping out water from inside the caisson would have an impact on the zooplankton within that water column, which the other alternatives avoid. Gravity-based anchor structures would result in a direct loss of existing fish habitat in a significant area, approximately 2,500 ft^2 per anchor structure. However, the gravity-based anchor system structures would provide a significant amount of hard substrate at different depth which would likely result in an artificial reef sustaining development of new biotic communities that have a potential to support significant marine populations. Such gravity-based anchor reefs would not be available to commercial and recreational fishermen so would not result in any direct positive economic impact.

Noise Impacts

For suction anchor and gravity-based anchors, sound generated by support vessel and barge movements and the thrusters of DP vessels would be the dominant source of underwater noise during anchor installation activities. An increase in underwater noise would be anticipated with grouted piles, mostly attributable to the use of drilling equipment. Noise impacts are expected to be greatest for driven piles due to the pulsed sounds of the hammer striking the pile. All noise impacts would be temporary for the duration of the installation.

Decommissioning Impacts

During decommissioning, driven pile and grouted pile anchors would be cut below the surface and abandoned in place. There would be a short-term and minor disturbance to surface sediments during this activity. Fluke anchors could be similarly abandoned in place with little disturbance to sediments, or backed out and recovered, resulting in minor disturbance to sediments, benthic habitat, and increased turbidity. For gravity-based anchors, they could be abandoned in place, potentially creating artificial reef habitat. If removed, it is likely that there would be short-term and minor disturbance to sediments during removal. The suction anchor could also be abandoned in place with little disturbance to sediments, or backed out and recovered, resulting in minor disturbance to sediments, benthic habitat, zooplankton, and increased turbidity. Backing out the suction anchor, achieved by pumping seawater into the caisson to pressurize and raise the anchor, would also result in further entrainment impacts. It is expected that this impact would be temporary as the area would recover to pre-construction conditions.

2.3.8.3 Alternative Anchoring Methods Conclusions

Given the environmental and technical considerations, the driven pile and suction anchor systems are characterized by several key advantages including a smaller footprint and fewer number of required support vessel transits during installation. Suction anchors are mostly used in a clay and fine sediment soil condition with limited stratification. Driven piles are generally used in sediment conditions consisting of more non-cohesive soil, such as sand, silt, and/or a more stratified conditions. The near surface sediment conditions at each of the TYMS locations, though predominantly clay, do contain elements of cohesive sand and silt. In addition, the conceptual sediment depositional environment of the area indicates that at depth the stratigraphy could be stratified sands, silts, and clay. In this type of geologic environment, driven piles would be preferred over suction piles. The conceptual depositional environment will be confirmed through an in-depth geotechnical evaluation completed to assist in final design. In addition, driven piles have the ability to restrain the TYMS from large overturning moments. Alternative anchoring methods are discussed further in Section 4 on a resource-by-resource basis.

2.3.9 Alternative DOF Locations

Criteria used to determine the feasibility of DOF locations included proximity to a gas supply pipeline for the Port, to gas supply header pipelines, and to existing natural gas infrastructure. Based on these immediate siting criteria, several pipelines were identified as viable options; however, as discussed in Section 2.3.4, only the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system and the HIOS/UTOS system were considered viable for the deepwater port location and therefore carried forth in the DOF siting analysis. Four potential DOF locations met the criteria for being in close proximity to the feasible pipeline systems: PSI Cameron Meadows Gas Plant (Alternative #1), Transco Station 44 (Alternative #2), a greenfield location adjacent to the PSI Cameron Meadows Gas Plant (Alternative #3), and a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Alternative #4) (Figure 2.3-5 and Figure 2.3-6).

Several additional criteria were then applied to these four potential DOF locations. These criteria included availability of land for siting of the compressor station, current land use, proximity to sensitive resources (e.g., streams, wetlands, wildlife habitat, NRHP sites, etc.), proximity to noise sensitive areas, and feasibility of air permitting. All four DOF site alternatives are located within a floodplain; therefore floodplains were not used as a screening criteria. Since DOF site locations are necessarily tied to existing onshore pipeline location, site alternatives outside of a floodplain area could not be identified.

Limited environmental data are available for Alternative #4 as Delfin LNG determined that the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC was not a commercially viable and necessary business, legal and regulatory efforts have therefore not been undertaken by the Applicant, as discussed in Section 2.3.4.1. However, because the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC pipeline met the siting criteria it was carried forward for analysis in this final EIS. Likewise, impacts from construction of Alternative #4 have been analyzed in this final EIS.

All the alternative sites were similar in comparison of impacts. Each had about the same number of noise sensitive areas. However, Alternative #1 provides more acreage, 78.9 acres as opposed to 49.1 acres for Alternative #2, 21.7 acres for Alternative #3, and 19.3 acres for Alternative #4; and is more developed, 73.9 percent developed as opposed to 55.2 percent developed for Alternative #2, 7.4 percent for Alternative #3, and 0 percent for Alternative #4. However, all alternative locations would be sited in areas where similar development is existing. Alternative #1 has less impacts on wetlands, no impacts as opposed to 0.2 acre for Alternatives #2 or #4, and 3.3 acres for Alternative #3. Prime farmland soil impacts would be greatest at Alternative #1 (28.1 acres) as opposed to Alternative #2 (18.7 acres), Alternative #3 (10.7 acres), and Alternative #4 (0.0 acres).

As previously mentioned, the Secretary respects an applicant’s expertise to identify those LNG deepwater port locations that represent viable business opportunities and relies on applicants to present reasonable and objective consideration of alternative locations to support their license applications. Additionally, development of a greenfield site (Alternatives #3 and #4) would likely result in greater impacts to natural resources as compared with re-development and/or modifications to existing sites. Delfin LNG began discussions with both Transco and PSI about the use of the available land on their respective properties. After discussion, Delfin LNG determined that Alternative #1 would be their preferred location for the siting of the compressor station while Alternative #2 would be their preferred location for the siting of the meter station and interconnection with gas supply header pipelines. No other alternatives were analyzed for siting of the DOF.

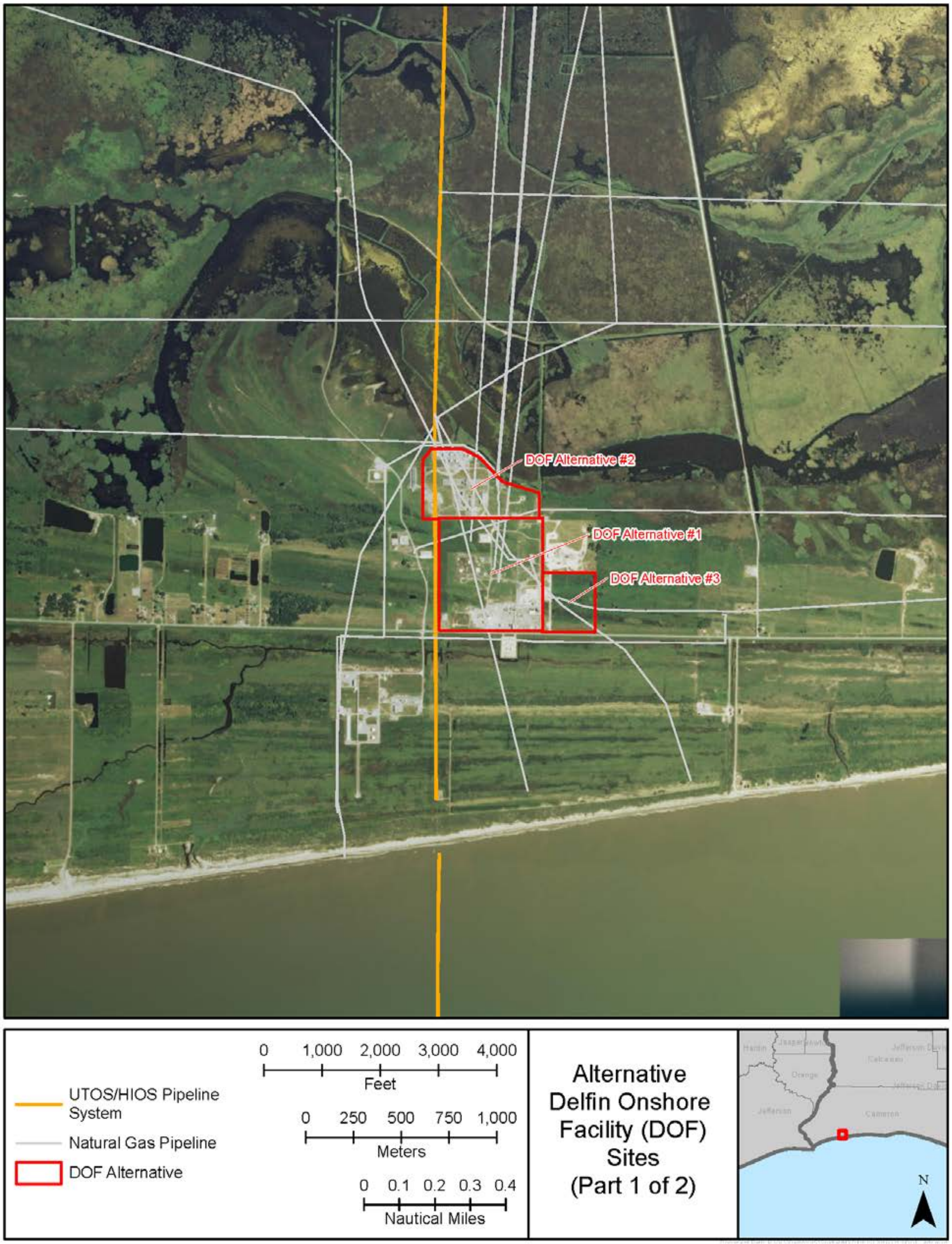


Figure 2.3-5. Alternative Delfin Onshore Facility (DOF) Sites (Part 1 of 2)

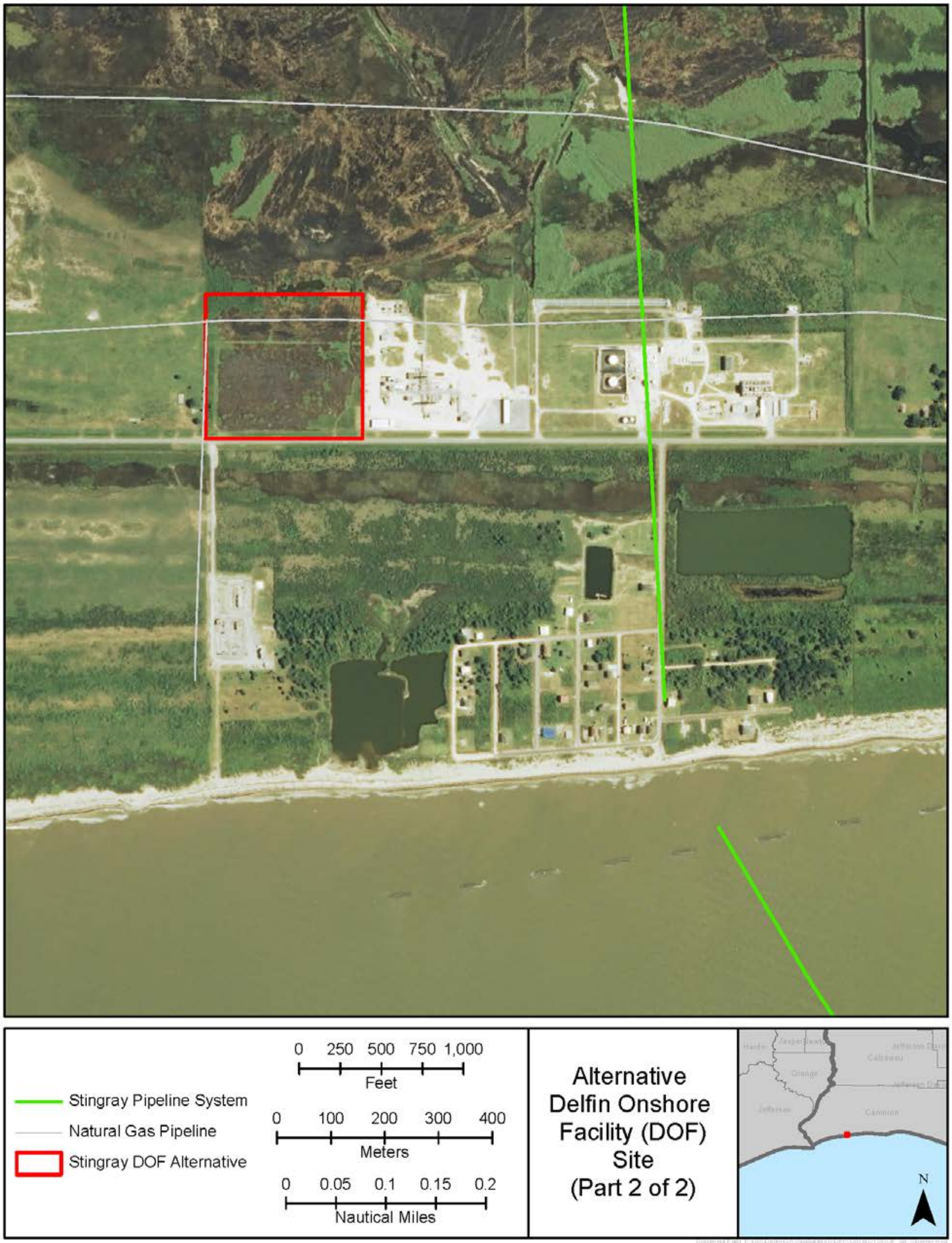


Figure 2.3-6. Alternative Delfin Onshore Facility (DOF) Site (Part 2 of 2)

2.3.10 No Action Alternative

The No Action Alternative refers to the continuation of existing conditions of the affected environment, without implementation of the proposed Project. Inclusion of the No Action Alternative is prescribed by the Council on Environmental Quality's (CEQ) NEPA implementing regulations and serves as a benchmark against which Federal actions can be evaluated. Under the No Action Alternative, the infrastructure proposed by Delfin LNG would not be built or brought online, and the potential positive or negative environmental impacts identified in this final EIS would not occur. However, the proposed Project's objective to liquefy and export surplus domestic natural gas would not be satisfied under the No Action Alternative. Similarly, if the Secretary were to deny or postpone Delfin LNG's DWPA license application, the international demand for natural gas would not be met and international customers may seek other projects, either here in the United States or elsewhere, to satisfy the demand. Other license or certificate applications concerning proposals to export natural gas might be submitted to the Secretary or the Secretary of the Commission, or other means might be used to export natural gas, such as expansion or establishment of onshore LNG import terminals that would require construction of LNG export facilities, including storage tanks, liquefaction facilities, and compression facilities. These facilities would likely result in similar or greater impacts than the proposed Project. It is likely that market forces, which include consideration for environmental impacts and associated permitting time and mitigation costs, would ensure that the LNG facility projects that ultimately would be developed offer the optimal combination of environmental and financial benefits while being consistent with sustainable development in the regions for which they are proposed.

2.3.11 Energy Alternatives

Increased gas production from tight and shale formations have resulted in increased demand for gas to support fast growing industrial uses and energy consumption. Shale gas production increased from 11 percent of overall U.S. gas production in 2008 to more than 20 percent in 2010 and is projected to approach 50 percent by 2035 (EIA 2014a). In addition, with new technologies the United States has found a nearly 10 percent increase in "proved reserves" of natural gas (EIA 2015a) resulting in 354 Tcf in proved reserves. See Section 1.2 for a discussion on the demand for natural gas exports.

Fuel oil and coal, though a reasonable alternative to natural gas, have a higher output of air pollutants than natural gas. These pollutants (sulfur oxide, carbon dioxide, and other greenhouse gases) would decrease air quality and would result in secondary impacts associated with their production (coal mining and oil drilling), transportation (oil tankers, rail cars and pipelines), and refinement. Natural gas produces approximately one-third less carbon emissions to produce the same energy as crude oil and approximately one-half of the carbon emissions associated with coal (EIA 2014b). Natural gas is also a smaller contributor to greenhouse gases than fuel oil or coal in terms of combustion emissions. In addition, other fossil fuels contribute more to acid rain, smog formation, particulate formation, and visibility issues than natural gas, and natural gas does not result in the same solid and hazardous waste that result from other traditional power generation facilities.

During the scoping period, the Center for Biological Diversity requested that the alternatives analysis include a clean, sustainable energy alternative; however, the proposed Project is an export project and, as such, any alternatives considered must be exportable. Therefore, energy alternatives such as nuclear and renewable resources are not considered reasonable alternatives and are not discussed. Likewise, energy conservation measures are not considered a reasonable alternative and are not discussed in this EIS.

Other LNG Export Terminals

There are currently 16 proposals for LNG import/export facilities within the Gulf Coast region. Of the 16 facilities, only 3 are existing facilities: Freeport LNG, Sabine Pass LNG, and Cameron LNG. Of these 3 facilities, only the Cheniere's Sabine Pass facility is operating as an export facility. It is the jurisdiction of the DOE/FE to authorize licenses for the export of LNG. Delfin LNG received an authorization for the export of 657.5 Bscf/yr of LNG to free-trade agreement nations on February 20, 2014. Because Delfin LNG has received DOE/FE authorization to export LNG, other LNG export terminals are not considered as potential alternatives to the proposed Project.

2.4 Identification of the Agencies' Preferred Alternative

The CEQ regulations indicate that this final EIS "identify the agency's proposed Project or alternatives, if one or more exists…unless another law prohibits the expression of such preference" (40 CFR 1502.14[e]). Under the DWPA, MARAD has the decision-making authority to approve, approve with conditions, or deny a License Application for a deepwater port. Because MARAD is the decision-making authority, identifying its preferred alternative could be interpreted as inappropriate prior to the Secretary's assembling, reviewing, and analyzing all of the relevant information pertaining to the License Application, as required under the DWPA. As such, the Secretary will defer identification of the agency's preferred alternative until a decision is made to approve or deny a deepwater port License. If the License is approved, the Secretary will indicate the agency's preferred alternative in its Record of Decision issued under the DWPA.

3.0 AFFECTED ENVIRONMENT

3.1 Introduction

Collectively, the area encompassing the deepwater port locations and transit routes is called the Region of Influence (ROI). The ROI for specific resources is further defined as needed. Proposed Port Delfin LNG Project (Project) alternatives are located within the same general vicinity as the proposed Project location, and the affected area would be similar for all locations.

The proposed Project has offshore and onshore components; the affected environment for the proposed offshore components, including existing pipelines and the proposed West Cameron (WC) 167 bypass, pipeline laterals, and proposed Delfin Port (Port), is addressed in Sections 3.2 through 3.10, while the affected environment for the proposed onshore components, including the proposed Delfin Onshore Facility (DOF), is addressed in Sections 3.11 through 3.17. This distinction and organization of the document allows for more focused agency review at the State and Federal level. The socioeconomic environment, however, is only addressed in Section 3.18. While socioeconomic conditions for certain industries such as commercial fishing and marine commerce physically occur offshore, these environments are human-centric, and discussion of these resources, therefore, is included in the final subsection of this chapter.

OFFSHORE AFFECTED ENVIRONMENT

3.2 Offshore Water Resources

This section is limited to discussion of offshore water resources; water resources located onshore are addressed in Section 3.11.

3.2.1 Definition of the Resource

In this document, offshore water resources are defined as the physical and chemical characteristics of a waterbody that affect its ability to maintain, support, and benefit ecosystems. More specifically, the proposed Project is associated with coastal and marine ecosystems where the water is influenced by multiple river drainages that contribute to sediment loading that have a major influence on the Gulf of Mexico environment. Natural marine processes include internal mixing and circulation patterns in the water column that act to influence (both positively and negatively) water quality. Coastal and marine environments are primarily influenced by temperature, salinity, dissolved oxygen (DO), nutrients, pH, toxic contaminants and turbidity (i.e., ambient loading of suspended matter). Various constituents from point and non-point sources including trace metals or organic compounds also have the ability to adversely affect water quality. These parameters can potentially influence and alter the quality of the water, in turn affecting the biological resources present and their associated habitat.

Coastal waters are defined as the nearshore waters of a coastal state extending roughly to 12 nautical miles, also commonly known as territorial waters. Coastal waters are dominated by tides, nearshore circulation, freshwater discharge from rivers and local precipitation. Coastal waters are influenced by inflows of freshwater interacting with the tidal actions of saltwater. This area of mixing between freshwater and marine waters forms estuarine habitats such as marshes, mangroves and coastal wetlands around the Gulf Coast.

Marine waters are defined as the offshore waters of the continental shelf and beyond. Marine waters generally lie seaward of coastal waters and are hydraulically dominated by tides and currents; have salinity levels representative of natural seas; and merge into and become part of the deepwater environment of the Gulf of Mexico.

3.2.2 Laws and Regulations

In addition to the Deepwater Port Act (DWPA) and National Environmental Policy Act (NEPA), the following laws and regulations apply to offshore water resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- Clean Water Act (CWA), Sections 312, 401, 402, and 404
- Rivers and Harbors Act, Section 10
- Coastal Zone Management Act (CZMA)
- Executive Order (EO) 11988, *Floodplain Management*, as amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*
- Louisiana State and Local Coastal Resources Management Act of 1978

The proposed Port would be located in Federal waters within the Bureau of Ocean Energy Management (BOEM-)designated WC Area, off the coast of Louisiana, and is therefore under the jurisdiction of the U.S. Environmental Protection Agency (USEPA) Region 6 for water related permitting. The proposed coastal portion of the pipeline is under the jurisdiction of the Louisiana Department of Environmental Quality (LDEQ), which regulates activities that have a "direct and significant impact on coastal waters", as well as the Texas General Land Office (GLO).

The U.S. Army Corps of Engineers (USACE) Mississippi Valley Division will also have jurisdiction over all water-based construction activities for the proposed Project. Natural resources of concern include both the use of water for the proposed Project and the maintenance of water quality as well as the biological resources residing in the marine environment.

The proposed Project would also need to conform to the International Convention for the Prevention of Pollution from Ships (MARPOL), adopted in 1973 and modified by the Protocol of 1978 (MARPOL 73/78). All signatories of the MARPOL Convention must be compliant with regulations that prevent and minimize pollution from ships, both accidental and from routine operations.

3.2.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- USEPA CWA Section 312 Standards for Marine Sanitation Devices,
- USEPA CWA Section 401 Water Quality Certification,
- USEPA CWA Section 402 National Pollution Discharge Elimination System (NPDES) permit,
- USACE CWA Section 404 permit,
- Rivers and Harbors Act Section 10 permit,
- Federal Emergency Management Administration (FEMA) Floodplain Management Consultation,
- Louisiana Pollutant Discharge Elimination System Permit (LPDES) permit for stormwater management, and
- Louisiana Department of Natural Resources (LDNR) and Texas GLO CZMA consistency determination.

3.2.4 Existing Threats

Estuarine ecosystems are primarily affected by humans in the form of upstream withdrawal for agricultural, industrial and domestic purposes, contamination by industrial and sewage discharges and agricultural runoff containing pesticides and herbicides, and habitat alterations. During a USEPA (2012) assessment of the ecological conditions of the Gulf of Mexico estuaries, the Calcasieu Lake estuary was classified to be in poor condition, primarily due to low DO, sediment related contaminants and a high level of degraded benthos. The primary terrestrial source affects conditions at the proposed Project location is the Mississippi River, which drains more than 40 percent of the contiguous United States before discharging to the Gulf of Mexico. This region ranks highest of all coastal regions in the United States in the number of wastewater treatment plants (1,300), number of industrial point sources (2,000), percentage of land use devoted to agriculture (31 percent), and application of fertilizer to agricultural lands (62,000 tons of phosphorus and 758,000 tons of nitrogen) (USEPA 1999a).

The Mississippi River discharges high volumes of suspended sediment and nutrients to the Gulf of Mexico. While these nutrients are important in sustaining marine life at moderate concentrations, excessive nitrogen and phosphorous entering the Gulf of Mexico support algal blooms that subsequently die and decompose, leading to depletion of oxygen below levels necessary to sustain most marine life. Development of a stratified water column in the gulf basin causes a separation of warmer water in the upper water column layer or epilimnion from the colder water in the hypolimnion. This separation layer between the two water layers is referred to as the temperature-induced thermocline. The depleted oxygen levels in the hypolimnion remain isolated from the oxygenated epilimnion. This isolated hypoxic depth interval (i.e., oxygen deficit) is commonly referred to as the "Dead Zone" in the Gulf of Mexico. Historical sampling of the water column in vicinity of the proposed Project revealed nutrients to be slightly higher in the near bottom waters (Table 3.2-1). The hypoxic "Dead Zone" is the second largest human-caused coastal area of low oxygen in the world. It stretches from the mouth of the Mississippi River into Texas waters, and on some occasions it has extended east of the Mississippi River (LUMCON 2014).

Table 3.2-1. Hydrographic and Nutrient Data from Oceanographic Stations near the Proposed Project Area

Station	Depth (meter)	Salinity (ppth)	Temp. (°C)	Oxygen (mL/L)	Nitrate (μmol/L)	Nitrite (μmol/L)	Ammonium (μmol/L)	Phosphate (μmol/L)	Silicate (μmol/L)
1	0	29.0	19.8	5.5	0.02	0.05	0.22	0.11	14.0
1	6	30.3	20.7	5.2	0.12	0.1	0.67	0.14	12.5
1	12	30.8	18.6	5.2	0.14	0.13	0.86	0.15	11.7
2	0	33.5	19.2	5.5	0.12	0.02	0.03	0.05	1.5
2	7	33.6	19.2	5.4	0.17	0.01	0.02	0.03	1.4
2	15	33.6	19.0	5.4	0.17	0.01	0.02	0.04	1.4
3	0	30.8	19.4	5.5	0.12	0.02	0.08	0.03	13.9
3	9	34.3	19.3	4.7	0.19	0.24	0.54	0.10	7.0
3	20	34.9	19.2	4.6	0.05	0.20	0.71	0.11	6.1
4	3	31.0	19.8	5.4	0.24	0.01	0.02	0.03	14.6
4	9	32.2	19.6	5.1	0.41	0.02	0.00	0.01	11.3
4	17	35.0	19.6	3.5	0.88	0.06	0.01	0.08	12.4

Key:
ppth = parts per thousand
μmol/L = micromole per liter
mL/L = milliliter per liter

Other threats to benthic resources in nearshore Gulf of Mexico waters are physical disturbance from energy-related activities and accidental large oil spills. Energy projects under BOEM jurisdiction are required to consider impacts on benthic resources in the permit application and associated impact evaluation. To streamline analysis of numerous projects with similar impacts, BOEM includes stipulations (BOEM lease-mandated conservation measures) in the lease agreements that serve to prevent impacts on sensitive benthic resources such as coral reefs, areas of topographic relief, and deepwater chemosynthetic communities. Impacts on ubiquitous soft-bottom benthic communities from routine activities associated with energy projects are documented in environmental assessments but are not considered to pose widespread threats to the persistence of these resources. Large oil spills may impact benthic resources, especially if applied dispersants cause the oil to sink to the seafloor. Discharge of chemical contaminants associated offshore energy projects is limited by permits and monitored by laboratory analyses and standard toxicity tests.

Plankton, including ichthyoplankton, also may be impacted by hypoxia and large oil spills. In addition, plankton may be physically injured or destroyed by impingement and entrainment in water intakes. Water taken in by vessel engines and other equipment that requires cooling water generally contains planktonic organisms that are too small or weak to escape the intake current. Larger planktonic organisms such as jellyfish may be impinged on screens designed to prevent such organisms from entering the intake; organisms that cannot escape the intake current become stuck on the screen and either die of the physical impact or become prey of more powerful animals. Planktonic organisms small enough to pass through the intake screens may be injured or killed as they pass through the equipment, where they may be crushed by impellers or be exposed to temperatures beyond their tolerance.

3.2.5 Existing Conditions

Existing conditions, including physical oceanography, coastal and marine environments, and the results of water quality sampling conducted by Delfin LNG, are discussed in the following subsections.

3.2.5.1 Physical Oceanography

The physical oceanography of the Gulf of Mexico includes those physical ocean conditions and processes, particularly the movement and water properties of ocean water itself. These conditions and processes include bathymetry, wave action, tides, winds, and currents. Each of these conditions is further described below.

Bathymetry

The proposed Project would be located on the continental shelf. The continental shelf portion of the Gulf of Mexico extends over a gradual slope from the coastline to the shelf break in water depths from approximately 387 to 492 ft (118 to 150 meters [m]). Mississippi and Atchafalaya River distributaries (along with an array of smaller drainages) discharge freshwater and sediment, which creates a shallow shelf on the Gulf of Mexico's northern rim.

Bathymetric surveys conducted by Delfin LNG indicate that water depths within the proposed Port survey area range from -56 ft to -73 ft mean lower low water (MLLW). The seafloor slopes to the south-southeast and varies from 2 ft per mile (0.022 degree) to 5 ft per mile (0.054 degree). Minor seafloor irregularity is visible in the northeast possibly due to shoals and/or outcrops. Water depths within the pipeline bypass survey area range from -43 ft to -50 ft MLLW. The water depth at the High Island Offshore System (HIOS) Valve Structure (OCS-G-04378) is approximately -47 ft MLLW.

Sidescan sonar records exhibit a variable reflectivity as well as a mottled seafloor across the survey area. The observed sonar reflectivity variations result from the irregular topography associated with shoals, particularly in the northeastern portion of the survey area, approximately 10,000 ft (3,048 m) northeast of the proposed Mooring #2 location and 6,000 ft (1,829 m) northeast of the proposed Mooring #1 location. Minor seafloor irregularity is visible in the northeast portion of the proposed WC 167 bypass, possibly due to shoals and/or outcrops. The seafloor exhibits a relatively shallow slope with a gradient of 3.1 ft per mile (0.03 degree) toward the south-southwest. There are no significant anthropogenic bathymetric features near the proposed Port facilities.

Wave Action

Wave height and direction data have been analyzed for the proposed Project area, based on historical data. Waves in this area are a function of both local wind patterns and the more regional Gulf of Mexico swells. The dominant wind direction in the vicinity of the proposed Port facilities for non-summer months is toward the west/southwest, with an offshore component. During the summer months, it is toward the north, mainly onshore.

Waves in the vicinity of the proposed Port facilities are generally average, less than 1 ft in height. Maximum significant wave heights of about 39 ft (12 m) can be expected approximately once every 25 years in deep waters (USACE 2010a). Wave heights of 12 ft (3.7 m) or more are seen 1 to 2 percent of the time, and waves greater than 20 ft (6 m) have been reported near the ROI (Texaco Group Inc. 2001).

Tides

Tidal currents in the Gulf of Mexico region are dominated by the regional lunar semi-diurnal tide referred to as the M2 tide. This inequality is emphasized during the two periods each month when the moon's declination is high (north or south). At these times, one high water and one low water tide are frequently seen each day. Tides in the open ocean are typically of smaller amplitude than tides along the coastline, mainly due to shoaling.

Tidal levels at WC 167 and WC 327 are the same, with semi-diurnal tides having a mean spring tidal range of 1.1 ft (0.34 m) and a spring tidal range of 1.8 ft (0.56 m). Direction of the currents is primarily north to south, perpendicular to the coast and alternating with the tidal stage, with a tidal current speed reaching 0.2 m per second at WC 327 (Texaco Group Inc. 2001).

The Gulf of Mexico typically has tropical conditions from May/June to October/November. As severe wind conditions occur during hurricanes and winter storms, the speed of surface currents can increase resulting in cooling of surface waters, and ultimately a mixing of stratified water layers. Waves can increase to velocities of 3.28 to 4.92 feet/second (ft/s) (100 to 150 centimeter/second [cm/s]) on the continental shelf during these events.

Winds

The climate along the northern Gulf of Mexico coast is a mixture of tropical and temperate zone conditions. Winds are variable near the coast due to moving cyclonic storms characteristic of the continent and the land/sea breeze regime, with less variability over open waters. On average, for non-summer months, wind direction is toward the west/southwest, with an offshore component. During summer months, the wind direction is toward the north, mainly onshore.

The Gulf of Mexico has the ability to develop cyclones because of the warm air contrasting with cold continental North American air. The main entry for Atlantic cyclone storms into the Gulf is the Yucatan Channel. On average, every 1 or 2 years, a tropical cyclone will move through the region with winds of 55 ft/s (17 meters/second [m/s]). Tropical cyclones can be a threat to navigation from late May into early November. On average, tropical cyclone winds are 55 ft/s (winds 17 m/s) and will move through the region every one to two years, while hurricane winds of 108 ft/s (33 m/s) can be expected every four to five years. Hurricane strength winds can be expected to reach 164 ft/s (50 m/s) about every 25 years.

Currents

The Gulf of Mexico is a semi-enclosed marine basin with inflow and outflow openings present in its southeastern corner. Therefore, the dominant circulation feature in the Gulf of Mexico, referred to as the Loop Current, is formed when inflow from the south enters the Gulf of Mexico northward before turning in a clockwise motion then exiting through the Straits of Florida as the Florida Current. At times, this loop forms a large and relatively deep current which then breaks off from the main flow (Elliot 1982) that migrates to the western basin. Warm, salty water within these rings spreads through the central and western

Gulf of Mexico (typically at speeds of 0.16 ft/s), which affects oceanic and atmospheric climatology (Wiseman and Sturges 1999). Warm-core rings can remain physically for up to one year or longer (Maul and Vukovich 1993). This results in multiple interacting eddies.

In the proposed Project area is the Louisiana-Texas Coastal Current near Cameron, Louisiana, and south of Isle Dernieres. Fluctuations in this current occur from wind stress alongshore and cross-shore. In the shallow water near the proposed Port, flow responds more quickly to wind and tides because they are more influential. Louisiana shelf water flows west to southwest due to surface circulation, wind, and longshore currents. A reversal is seen in surface flow during midsummer as Louisiana coast winds are weak in the south and southwesterly direction. Wind stress, in particular, is important in driving surface waters over the shelf in shallow areas, both seasonally and on storm scales (Johnson 2008). The major circulation patterns within the Gulf of Mexico are shown in Figure 3.2-1.

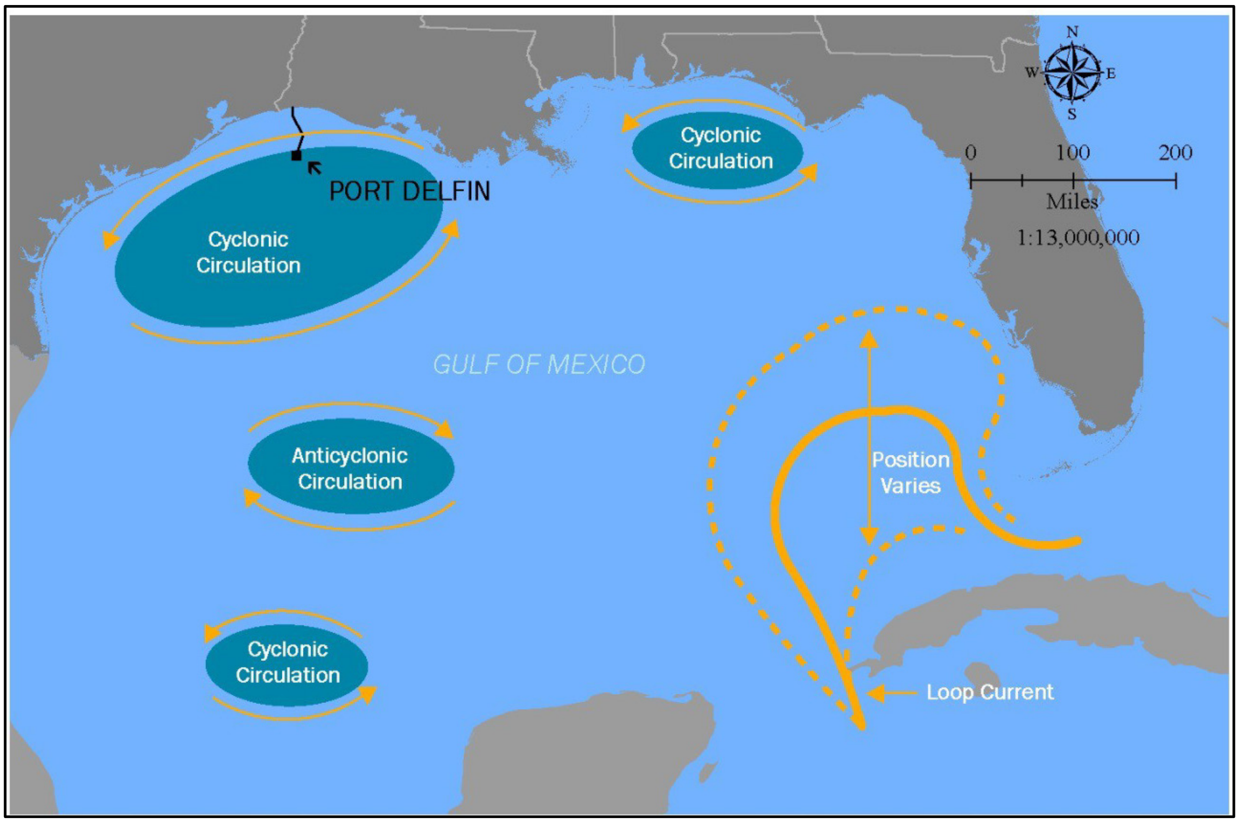


Figure 3.2-1. Currents in the Gulf of Mexico

3.2.5.2 Coastal Environment

The proposed offshore components and associated pipeline interconnects would be located within marine waters and include both Louisiana and Texas state waters. The proposed Port and associated pipeline segments would be located within marine waters of the Gulf of Mexico. While the proposed Port would not be located within coastal waters, operational activities and pipeline components would cross the coastal zones of Louisiana. Coastal and estuarine habitats provide food and shelter for shorebirds, migratory waterfowl, fish, invertebrates, reptiles and mammals. In addition, estuaries benefit humans by providing habitat for estuarine-dependent fish species that constitute more than 75 percent of commercial fishery harvest from the Gulf of Mexico (National Oceanic and Atmospheric Administration [NOAA] 1990). Within the proposed Project area, the estuaries of the Mississippi and Calcasieu Lake drainages form the most significant estuary systems present.

Data collected as part of NOAA's National Oceanographic Data Center (NODC) monitoring program, revealed several trends among nutrients and DO distributions in the Gulf of Mexico. Similar to the open ocean, maximum DO concentrations are highest near the surface and decrease with depth. This trend is due to the atmospheric exchange and photosynthetic productivity that occurs closer to the surface. On the other hand, nutrient profiles indicate the lowest levels are found near the surface and increase with depth. This trend is also a result of the light-dependent photosynthetic activity that occurs near the surface. In addition, deeper waters have higher nutrient concentrations.

3.2.5.3 Marine Environment

The proposed Project pipeline and Port structures occur within the influence of the Calcasieu Lake and Mississippi River estuarine systems of the Gulf of Mexico. The Calcasieu Lake estuarine system was considered to be in poor condition in the early 1990s due primarily to low DO, sediment contaminants, and a high level of degraded benthos. With more than 408 square miles (256 square kilometers [km]), the waters of this estuarine system average 3 ft (1 m) deep with a salinity of 12 practical salinity units (psu).

The proposed Port and associated pipeline would be located within both shallow and deeper marine waters. Beyond previously discussed factors affecting water quality, water quality of deep ocean zones can be affected by trace metals and hydrocarbons within the water column and sediments sourced from natural hydrocarbon seeps. An extensive network of hydrocarbon seeps exists throughout the continental slope of Gulf of Mexico. These seeps contribute hydrocarbons to the surface sediments and water column, particularly in the central Gulf of Mexico (Sassen et al. 1993a, 1993b). In addition to hydrocarbon seeps, other subsurface influences affecting sediments and bottom waters of the continental slope include seawater trapped during the settling of sediments, dissolution of underlying salt diapirs, containing authigenic (i.e., formed in situ) carbonate deposits, and deep-seated formation waters rich in barium.

Hydrocarbon seeps are extensive throughout the continental slope and contribute hydrocarbons to the surface sediments and water column, especially in the central Gulf of Mexico. Estimates of the total volume of seeping oil range widely, from 121,800 gallons per year (29,000 oil barrels per year) (MacDonald 1998) to 21,840,000 gallons per year (520,000 oil barrels per year) (Mitchell et al. 1999). In addition to hydrocarbon seeps, other fluids leak from the underlying sediments into the hypolimnion along the continental slope. These fluids have been identified from three sources: (1) seawater trapped during the settling of sediments, (2) dissolution of underlying salt domes, and (3) deep-seated formation waters. Contribution of hydrocarbons from the bottom sediments to the water column contribute additional carbon loading to these lower waters, further contributing to the observed oxygen deficit from enhanced chemical and biological oxygen demand.

3.2.5.4 Water Quality Sampling

No local water quality data were available for identifying potential water quality factors already present within the proposed Project area. To characterize the existing water quality within the proposed Project area, 14 samples were collected on December 15-16, 2015, and analyzed by a certified laboratory (Appendix H). These samples were collected at 0.5-mile intervals along the pipeline routes, including the proposed new laterals and bypass segments, as well as at each proposed tower yoke mooring system (TYMS). The locations of these samples are illustrated in Figure 3.2-2, and the full report of this sampling effort is included in Appendix H. Water samples were collected at both surface depths (0-1 ft) and near bottom depths (defined as the depth represented by 90 percent of the total depth of the water column) using an automated rosette sampler. Continuous measurements of specific conductivity, temperature and depth were also recorded via a conductivity-temperature-depth (CTD) measurement detector. Dissolved oxygen (DO) was also collected using a Sea-Bird Electronics 9+ Underwater Unit.

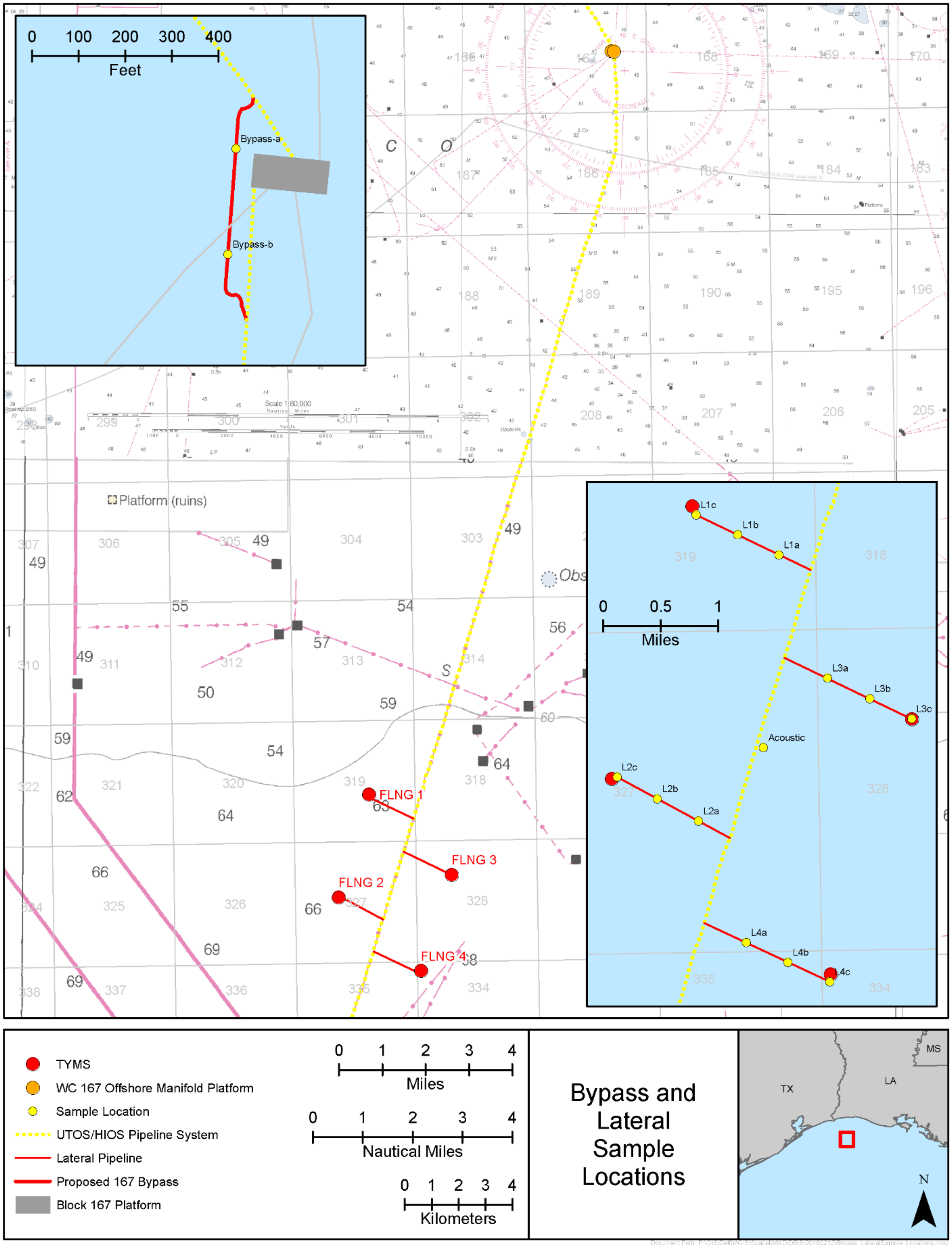


Figure 3.2-2. Bypass and Lateral Sample Locations

Surface water parameters analyzed in the collected samples included total suspended solids (TSS), total dissolved solids (TDS), biological oxygen demand (BOD), chemical oxygen demand (COD), nitrogen-ammonia, nitrogen-nitrate+nitrite, total phosphorous, target analyte list (TAL) total metals and target compound list (TCL): polychlorinated biphenyls (PCBs), pesticides and semi-volatile organic compounds (SVOCs). Table 3.2-2 summarizes the water quality data for detected constituents at the bypass and lateral sampling stations (Figure 3.2-2).

Table 3.2-2. Detected Compounds and Elements in Marine Waters at Bypass and Lateral Sampling Locations

Water Quality Parameter	Bypass Segment (N–2 Samples)		Lateral Segments (N–12 Samples)	
	Minimum (mg/L)	Maximum (mg/L)	Minimum (mg/L)	Maximum (mg/L)
Metals (mg/L)				
Aluminum	0.0613 J	0.183	0.0532 J	0.0824 J
Barium	0.0177 J	0.0226 J	0.0124 J	0.0152 J
Calcium	420	449	417	509
Magnesium	1,310	1,390	1,220	1,500
Potassium	409	434	408	485
Selenium	0.0075 J	0.0230 J	0.0123 J	0.0204 J
Sodium	9,480	10,600	9,370	10,900
Semi-Volatile Organic Compounds (mg/L)				
Bis(2ethylhexylphthalate	ND	0.0032 J	ND	0.043
Nutrients (mg/L)				
Ammonia	0.029 J	0.031 J	0.025 J	0.062 J
Phosphorous	ND	ND	ND	0.0200
Nitrate/Nitrite	ND	10.9	ND	1.87 J
General Water Chemistry				
Total Suspended Solids	7.26	9.60	3.68	16.6
Total Dissolved Solids	36,000	37,900	38,100	39,600
Chemical Oxygen Demand	200 J	240 J	220 J	360

Key:
mg/L = milligrams per liter
ND = below detection limits
J = Estimated concentration
Full report is contained in Appendix H.

Overall, in situ water chemistry results showed conductivity, pH and salinity to be at levels considered appropriate for typical offshore marine environments of the Gulf of Mexico (Table 3.2-3). Additionally, the majority of organic and inorganic analytes that were analyzed for were below the selected method detection limits (i.e., non-detected). A few ionic constituents including calcium, magnesium, potassium, and sodium were above detection limits. However, this was to be expected as these elements are abundant in marine environments. Total dissolved selenium was also detected in all samples. Of the 15 samples, Bis(2-ethylhexyl)phthalate (or DEHP), a plasticizer (softener) use in products made of PVC plastic, was detected at six of the sample locations. Physiochemical parameters such as TSS, TDS, and COD were within ranges that would be expected for marine waters. Samples were collected to characterize ambient concentrations of select parameters that reflect natural conditions in the marine waters of the Gulf of Mexico. In addition, the majority of the nutrient detections, besides nitrate/nitrite at L3-B Dup and Bypass B, were undetectable or very low (see Appendix H, Table 6). For the screening analysis, water quality criteria, standards and other relevant benchmarks were limited for many of the detected compounds. However, of those that were screened, phosphorous was the only constituent to exceed its water quality criteria at a single sampling location (see Appendix H, Table 6). This single exceedance did not reflect any trends identifying excess enrichment within the area of the proposed Project footprint

Table 3.2-3. In Situ Specific Conductivity, pH, Salinity, Temperature, and Dissolved Oxygen Measurements

Parameter	Bypass (n=4,136)		L1b (n=5,594)		L2a (n=7,562)		L3b (n=6,548)		L4b (n=4,969)	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
Specific Conductivity (S/m)	4.36-4.69	4.49	4.77-4.87	4.79	4.73-4.93	4.78	4.78-4.80	4.79	4.77-4.93	4.81
pH (su)	8.15-8.21	8.18	8.18-8.22	8.20	8.17-8.20	8.19	8.18-8.21	8.20	8.15-8.18	8.16
Salinity (PSU)	31.51-33.62	32.32	34.08-34.68	34.23	33.87-35.00	34.19	34.16-34.33	34.23	34.20-34.99	34.39
Temperature (°C)	20.01-20.70	20.27	20.83-21.15	20.91	20.73-21.38	20.87	20.77-20.95	20.89	20.85-21.35	20.95
Dissolved Oxygen (ml/L)	5.14-5.27	5.22	5.07-5.11	5.10	5.04-5.13	5.11	5.10-5.11	5.10	5.04-5.11	5.09

Key:
°C = degrees Celsius
ml/L = milliliters per liter
PSU = practical salinity units
S/m = Siemens per meter
Full report is contained in Appendix H.

3.3 Offshore Biological Resources

This section is limited to discussion of offshore biological resources; biological resources located onshore are addressed in Section 3.12.

3.3.1 Definition of the Resource

This section describes the biotic environment in the proposed Project ROI. The biological resources described here may be affected by proposed Project construction, operation, and decommissioning, and include benthic communities, plankton (including ichthyoplankton), fisheries, marine mammals, sea turtles, and marine birds.

3.3.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to offshore biological resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- National Marine Sanctuaries Act,
- Endangered Species Act (ESA),
- Marine Mammal Protection Act (MMPA),
- Migratory Bird Treaty Act (MBTA),

- EO 13158 Marine Protected Areas,
- EO 13089 Coral Reefs, and
- BOEM Notice to Lessees (NTL) No. 2009-G39.

The proposed Port would be located in Federal waters within the BOEM-designated WC Area, off the coast of Louisiana, and is therefore under the jurisdiction of NOAA for marine biological resource related permitting.

3.3.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- USEPA CWA Section 312 Standards for Marine Sanitation Devices,
- USEPA CWA Section 401 Water Quality Certification,
- USEPA CWA Section 402 NPDES permit,
- USACE CWA Section 404 permit,
- Rivers and Harbors Act Section 10 permit,
- NOAA Incidental Harassment Authorization, and
- NOAA Incidental Take Statement.

3.3.4 Existing Threats

Biological resources within the proposed Project ROI are varied, resulting in a wide variety of existing threats to these resources. Excess nutrient loading stimulates the production of large amounts of phytoplankton which eventually die, sink to the bottom, and decompose, consuming DO and contributing to the observed hypoxia that develops in deeper waters of the Gulf of Mexico. This existing "Dead Zone" negatively impacts marine species and habitat ranging from the benthic environment through the water column. Alterations to numerous waterways and estuaries has caused changes in water flow and increased freshwater volume that not only carries more nutrients into the surrounding marine environment, but also causes loss to wetlands, erosion of barrier islands and degrades estuarine environments (Gulf Coast Ecosystem Restoration Taskforce 2011). Pesticides and other contaminants such as organochlorine, pyrogenic polycyclic aromatic hydrocarbons (PAHs), herbicides such as Atrazine, polychlorinated biphenyls (PCBs), and trace inorganic (metal) pollutants, can accumulate in sediments and any disruption (i.e., resuspension and mixing) could allow them to re-enter the water column and, thus bioaccumulate and biomagnify, persisting within higher orders of ecological food webs and result in negative consequences to biological resources.

Other anthropogenic activities, such as oil and gas exploration throughout the Gulf of Mexico, have the potential to threaten biological resources in the event of spills and releases that could impact benthic communities, plankton (including ichthyoplankton), fisheries, marine mammals, sea turtles, and marine birds. As an example, the Deepwater Horizon oil spill of 2010 caused widespread impacts on Gulf of Mexico biological resources. However, even prior to Deepwater Horizon, other human and natural impacts such as increasing vessel traffic, overfishing, pollution, invasive species, habitat loss, climate change and hurricanes have degraded biological resources in the great Gulf of Mexico, as well as within the proposed Project ROI (NOAA 2015a).

Water use from existing shipping or land-based industrial cooling activities can also threaten biological resources through impingement and entrainment, where low swimming speeds of plankton, and eggs and larvae of marine species become trapped against intake screens (impingement) or drawn though mechanical systems along with the water (entrainment). Such losses can not only impact the populations of the individual species removed, but also affect higher order organisms that may depend on these planktonic species for food. Shipping activities can also directly impact marine mammal and sea turtle species through the risk of ship strikes which can cause injury or mortality. Vessel traffic additionally results in noise, light, and air impacts, as well as potential for spills. In addition, rising ocean temperatures can potentially alter ecosystems, and species that are already threatened or endangered are especially imperiled.

3.3.5 Offshore Threatened and Endangered Species

The ESA (16 United States Code [U.S.C.] 1531–1534) was established to protect species vulnerable to extinction, as well as their environments. Marine organisms are under the jurisdiction of the NOAA National Marine Fisheries Service (NOAA Fisheries), while terrestrial and freshwater organisms are overseen by the U.S. Fish and Wildlife Service (USFWS) (see Section 3.12), though some species require special consideration and may be managed by both agencies. The ESA defines "endangered" as a species in danger of extinction in all or a significant portion of its range. "Threatened" is then defined as a species that is likely to become endangered in the foreseeable future. If a Federal agency undertakes an activity that may impact an "endangered" or "threatened" species, they must first consult with the USFWS or NOAA Fisheries, or both, according to Section 7 of the ESA.

Under the ESA, the U.S. Coast Guard (USCG) has the responsibility to determine whether or not the proposed Project would adversely affect Federally listed threatened or endangered species and their critical habitat. If, upon review of existing data or data provided by the Applicant, the USCG determines that either a species or habitat or both might be affected by the proposed Project, the USCG must prepare a Biological Assessment (BA) to consider the type of effect and extent of impact. In accordance with Section 7(c)(1) of the ESA and Section 102 of NEPA, this Environmental Impact Statement (EIS) would serve as the BA for the Proposed Action. In addition to an impact analysis, recommendations must be made for ways to eliminate or mitigate potential adverse effects. The USCG issued a request for informal consultation and technical assistance to NOAA Fisheries and USFWS on January 8, 2016, but has yet to receive a response. All consultation correspondence to date is located in Appendix D of this final EIS.

The BA (also see Sections 1.4.1 and 4.3 of this final EIS) prepared by the USCG would aid in the interagency consultation determination of whether the potential impacts from the proposed Project are likely to jeopardize any listed species or result in the destruction or adverse modification of designated critical habitats. After consultation, the Services would issue a Biological Opinion (BO) expressing their opinion about the potential for impacts to occur. If NOAA Fisheries or USFWS in its BO determine that the proposed Project would result in take, the agency may decide to issue an incidental take statement specifying the amount of take allowed. If the USCG determines that no Federally listed (or proposed) species or designated critical habitat would be affected by the proposed Project, no further action is necessary. Two species have designated critical habitat that overlaps with the ROI, the piping plover (discussed in Section 3.12.5.1) and the loggerhead sea turtle (discussed in Section 3.3.5.2). The designated critical habitat for the piping plover is not expected to be impacted or adversely affected by the proposed Project because existing infrastructure (Section 2.0) will be used without requiring any additional construction in any designated critical habitat for the piping plover. As a result, critical habitat for this species is not discussed further in this EIS.

As part of the agency consultation process on the proposed Project, on March 2, 2015, Delfin LNG sent a letter providing details on the proposed Project to the USFWS Louisiana Ecological Services Office located in Lafayette, Louisiana. The USFWS provided a response on March 17, 2015, requesting that the proposed Project evaluate potential impacts on the following species under agency jurisdiction:

- West Indian manatee (*Trichechus manatus*; Endangered)
- Federally listed threatened and endangered sea turtles with emphasis on:
  - loggerhead sea turtle (*Caretta caretta;* Threatened)
  - Kemp's ridley sea turtle (*Lepidochelys kempi;* Endangered)

All Federally listed threatened and endangered species of marine mammals, sea turtles, or birds that have potential habitat or known occurrence in the ROI are described in further detail below. In addition to providing data on species known from the ROI, Table 3.3-1 includes species that may occur in the Action Area. The Action Area is defined as all areas that may be affected directly or indirectly by the Federal action. It includes not only the immediate area involved in the proposed action but encompasses the geographic extent of environmental changes (i.e., the physical, chemical, and biotic effects) that would result directly and indirectly from the action. It is typically larger than the area directly affected by the Proposed Action itself and is intended to include species or critical habitat that may be present in the entire potentially affected area. In this case, the Action Area includes the U.S. Exclusive Economic Zone (EEZ) to cover the portion of the project containing the LNGC shipping routes. The EEZ is a legal jurisdictional area that consists of those areas adjoining the territorial sea of the United States and which extends 200 nautical miles (370 km) from the coastline. While the majority of the impact analyses for fish, marine mammals, and sea turtles are localized to the proposed Port location, the Action Area for this analysis is extended in order to cover impacts from the liquefied natural gas carrier (LNGC) shipping routes on these resources, and to account for potential nexus with other ESA or MMPA species outside of the proposed Port location Table 3.3-1 includes likelihood of occurrence in the Action Area/EEZ) and in the proposed Project area for marine mammals, sea turtles, and fish.

Table 3.3-1. Gulf of Mexico Marine Mammal Summary with Likelihood of Occurrence

Common Name	Species Name	Protection Status	Potential Occurrence in LNGC Transit Routes to Proposed Port Location from the EEZ	Potential Occurrence in Proposed Port Location
Sei Whale	*Balaenoptera borealis*	ESA Listed Endangered and MMPA Depleted, throughout its range	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare
Blue Whale	*Balaenoptera musculus*	ESA Listed Endangered and MMPA Depleted, throughout its range	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare
Fin Whale	*Balaenoptera physalus*	ESA Listed Endangered and MMPA Depleted, throughout its range	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare
Northern Right Whale	*Eubalaena glacialis*	ESA Listed Endangered and MMPA Depleted, throughout its range	Unlikely / rare	Unlikely / rare
Humpback Whale	ESA Endangered/ MMPA	ESA Listed Endangered and MMPA Depleted, throughout its range	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare
Bryde's Whale	*Balaenoptera edeni*	ESA Listed Candidate in the Gulf of Mexico and MMPA Protected throughout its range	Likely	Unlikely
Minke Whale	*Balaenoptera acutorostrata*	No ESA Listing / MMPA Protected throughout its range	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely
Sperm Whale	*Physeter microcephalus*	ESA Listed Endangered and MMPA Depleted, throughout its range	Likely	Unlikely

Table 3.3-1. Gulf of Mexico Marine Mammal Summary with Likelihood of Occurrence (continued)

Common Name	Species Name	Protection Status	Potential Occurrence in LNGC Transit Routes to Proposed Port Location from the EEZ	Potential Occurrence in Proposed Port Location
Pygmy Sperm Whale	*Kogia breviceps*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep and warm water; distribution not well known; common from strandings)	Unlikely / rare
Dwarf Sperm Whale	*Kogia simus*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep water; distribution not well known)	Unlikely / rare
Cuvier's Beaked Whale	*Ziphius cavirostris*	No ESA Listing / MMPA Protected throughout its range	Likely	Unlikely / rare
Blainville's Beaked Whale	*Mesoplodon densirostris*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep water; distribution not well known)	Unlikely / rare
Gervais' Beaked Whale	*Mesoplodon europaeus*	No ESA Listing / MMPA Depleted throughout its range	Potential (prefers deep and warm water; distribution not well known; common from strandings)	Unlikely / rare
Sowerby's beaked whale	*Mesoplodon bidens*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep and warm water; distribution not well known; common from strandings)	Unlikely / rare
Melon-headed Whale	*Peponocephala electra*	No ESA Listing / MMPA Protected throughout its range	Unlikely / rare	Unlikely / rare
Pygmy Killer Whale	*Feresa attenuata*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep and warm water; distribution not well known)	Unlikely / rare
False Killer Whale	*Pseudorca crassidens*	No ESA Listing / MMPA Protected throughout its range	Unlikely / rare	Unlikely / rare
Killer Whale	*Orcinus orca*	No ESA Listing / MMPA Protected throughout its range	Likely	Unlikely / rare
Short-finned Pilot Whale	*Globicephala macrorhynchus*	No ESA Listing / MMPA Protected throughout its range	Likely	Unlikely / rare
Rough-toothed Dolphin	*Steno bredanensis*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep and warm water; distribution not well known)	Unlikely / rare
Fraser's Dolphin	*Lagenodelphis hosei*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep water; distribution not well known)	Unlikely / rare
Bottlenose Dolphin (multiple stocks)	*Tursiops truncatus*	No ESA Listing / MMPA Depleted in the Gulf of Mexico	Likely / Common	Likely / Common
Risso's Dolphin	*Grampus griseus*	No ESA Listing / MMPA Protected throughout its range	Likely	Unlikely / rare

Table 3.3-1. Gulf of Mexico Marine Mammal Summary with Likelihood of Occurrence (continued)

Common Name	Species Name	Protection Status	Potential Occurrence in LNGC Transit Routes to Proposed Port Location from the EEZ	Potential Occurrence in Proposed Port Location
Atlantic Spotted Dolphin	*Stenella frontalis*	No ESA Listing / MMPA Protected throughout its range	Likely	Likely / Common
Pantropical Spotted Dolphin	*Stenella attenuata*	No ESA Listing / MMPA Protected in the Gulf of Mexico	Likely	Unlikely / rare
Striped Dolphin	*Stenella coeruleoalba*	No ESA Listing / MMPA Protected throughout its range	Likely	Unlikely / rare
Spinner Dolphin	*Stenella longirostris*	No ESA Listing / MMPA Protected in the Gulf of Mexico	Likely	Unlikely / rare
Clymene Dolphin	*Stenella clymene*	No ESA Listing / MMPA Protected throughout its range	Potential (prefers deep water; distribution not well known)	Unlikely / rare
West Indian Manatee	*Trichechus manatus*	No ESA Listing / MMPA Protected and strategic stock in the Gulf of Mexico	Unlikely / rare	Unlikely / rare
Hawksbill turtle	*Eretmochelys imbricata*	ESA Listed Endangered throughout its range	Likely	Likely
Kemp's ridley turtle	*Lepidochelys kempii*	ESA Listed Endangered throughout its range	Likely	Likely
Loggerhead turtle	*Caretta*	ESA Listed Threatened in the Gulf of Mexico	Likely	Likely
Green turtle	*Chelonia mydas*	ESA Listed Threatened in the Gulf of Mexico	Likely	Likely
Leatherback turtle	*Dermochelys coriacea*	ESA Listed Endangered throughout its range	Likely	Likely
Smalltooth sawfish	*Pristis pectinata*	ESA Listed Endangered throughout its range	Unlikely	Unlikely
Gulf sturgeon	*Acipencer oxyrinchus*	ESA Listed Threatened throughout its range	Unlikely	Unlikely

Key:
ESA = Endangered Species List
MMPA = Marine Mammal Protection Act

Species known to occur in the Action Area include a total of 29 MMPA protected marine mammals of which 6 are also ESA protected species. It also includes five ESA listed sea turtles. Species known to occur in the proposed Port location include a total of seven threatened or endangered ESA-listed species (two marine mammals and five sea turtles; see Table 3.3-1).

3.3.5.1 Marine Mammals

Six large whale species that occur in the Gulf of Mexico are listed as threatened or endangered: one toothed whale (sperm whale, *Physeter microcephalus*), and five baleen (whales that feed with a baleen plate vs. teeth) whales: sei whale (*Balaenoptera borealis*), fin whale (*Balaenoptera physalus*), blue whale (*Balaenoptera musculus*, humpback whale (*Megaptera novaeangliae*), and North Atlantic right whale (*Eubalaena glacialis*). These whales are all protected under both the ESA and the MMPA. All five ESA-listed baleen whale species that occur in the Gulf of Mexico are considered to potentially occur in the EEZ though are generally less common in northern Gulf of Mexico waters (BOEM 2011a). The endangered sperm whale is the only ESA-listed whale that is known to commonly occur in the Gulf of Mexico and may be considered a resident species. It is likely in the EEZ though not expected in the proposed Port location. The proposed Port location does not provide habitat for the large whales because waters here are inshore, shallow (sperm whales in particular are known from deep water habitats), and do not provide any distinct high value habitat or prey for these deeper water–preferring whales. One additional large whale marine mammal species, the Bryde's whale (*Balaenoptera edeni*), occurs commonly in the Gulf of Mexico. The Bryde's whale population that may occur in both the proposed Port location and EEZ waters is the Gulf of Mexico Distinct Population Segment (DPS) and is a candidate species for ESA listing (80 Federal Register [FR] 18343). In general for these ESA listed or candidate species, their exposure to Project stressors from actions in the proposed Port location is possible but not plausible. Similarly, the ESA-list endangered West Indian manatee (*Trichechus manatus*) is so rare in northern Gulf of Mexico waters that it is eliminated from further consideration.

Marine mammal populations are influenced by various natural factors and human activities. These factors affect marine mammal populations directly by injuring or inducing mortality outright, or indirectly by reducing survival or lowering reproductive success of individuals. Human impacts on marine mammals include fisheries interactions (such as gear entanglement, shootings by fishermen, or bycatch [accidental or indirect catch]), ship strikes, noise stressors, chemical pollution (oil spills, fluid spills, etc.), and general habitat deterioration or destruction.

Entanglement or bycatch of animals in fishing nets and gear is a major factor in marine mammal mortality. Ship strikes negatively impact individuals and may affect the population of a species, particularly in small populations. Activity in shipping channels, from fishery or other vessels, can result in ship strikes, as well as disturb whale habitat by occupying or destroying important whale feeding or breeding areas. Recreational use of marine areas, whale watch tours, and increased boat traffic can displace whales from their habitat. Whales are subject to acoustic impacts from vessel operation; oceanographic research or energy exploration using active sonar, even military operations, can all increase underwater noise and are of increasing concern. Noise is of particular concern to marine mammals because many species use sound as a primary sense for navigating, finding prey, avoiding predators, and communicating with other con-specific individuals. Noise can cause behavioral disturbances, mask other sounds including their own vocalizations, and may even result in injury and, in some cases, lead to death. Human-caused noises in the marine environment come from shipping, seismic and geologic exploration, military activity, commercial, industry, and private sources. In addition, noise from whale-watching vessels in the vicinity of marine mammals is a stressor. Chemical pollution is threat. Chemical pollutants and pesticides flow into the marine environment from human use on land or from marine spills. Toxins are absorbed into the bodies of marine mammals, accumulating in their blubber (this process is often called bioaccumulation) or transferring to the young via mothers' milk. Important factors that determine the levels of pesticides and industrial pollutants that accumulate in marine mammals are gender (i.e., adult males have no way to transfer pesticides whereas females may pass pollutants to their calves through milk), habitat, and diet. Living closer to the source of pollutants and feeding on higher-level organisms increases the potential to accumulate toxins. Oil and other chemical spills are a specific type of ocean contamination known to have negative effects on some marine mammal species. Oil spills can affect marine mammals both directly by the oil itself and indirectly by activities during the containment and cleanup phases and through impacts on prey and habitat. Marine mammals can be impacted by the changes in habitat from the presence of chemicals and dispersants in their habitat, by oil introduction, and from increased human presence in the environment. Any of these factors may trigger changes in prey distribution, water quality, noise levels, and other environmental variables. Potential behavioral responses to these various threats include displacement from primary habitat and the disruption of social structure, changes in prey availability and in feeding activities and success, effects on reproductive behavior, and changes to migration.

The threats listed above affect all marine mammals in the Gulf of Mexico including all the large ESA-listed whales in the ROI and Action Area. They can become entangled in fishing gear, either trailing gear while they swim, or they may become anchored and drown in the gear. Entanglement causes injury, death, and can affect movements, foraging, and other behaviors. Whales in the Project EEZ are subject to entanglement from the swordfish and thresher shark drift gillnet fishery. The large whales are all subject to ship strikes which can injure or kill them. A potential impact of particular concern in the EEZ portion of this project are ship strikes. All of the large whales that could occur in the EEZ or Proposed Port Location have been documented as having suffered ship strikes (Jensen et al. 2004; Waring et al. 2015). Fin whales may be the most susceptible or at least are the most frequently reported, followed by humpback whale, North Atlantic right whale, and sperm whales (Jensen et al. 2004) though blue and sei whales and several other MMPA species in the Gulf of Mexico have been documented as having had injury or mortality from ship strikes.

Sei Whale

The sei whale is listed as endangered under the ESA and depleted under the MMPA. Critical habitat is not designated for sei whales. There is no resident stock of sei whales considered to occur in the Gulf of Mexico. There are two stocks of sei whales in the northwestern Atlantic Ocean: the Nova Scotia stock and Labrador Sea stock (NOAA Fisheries 2011). The Nova Scotia stock occurs in the waters of the U.S. EEZ where during the spring and summer, it may occur in the northern portions of the U.S. EEZ; the Gulf of Mexico is the southernmost portion of its range (NOAA Fisheries 2015a).

Fin Whale

The fin whale is listed as endangered under the ESA and depleted under the MMPA. Critical habitat is not designated for fin whales. The western North Atlantic fin whale stock was assessed for management and fin whales off the eastern United States are believed to constitute a single stock and are currently considered the management unit under NOAA Fisheries jurisdiction (NOAA Fisheries 2015b). However, the stock identity of North Atlantic fin whales is still uncertain. In the western Atlantic, fin whales winter from the edge of sea ice south to the Gulf of Mexico and the West Indies (NOAA Fisheries 2015b). There is no resident stock of fin whales considered to occur in the Gulf of Mexico.

Blue Whale

Blue whales are listed as endangered under the ESA and depleted under the MMPA. Critical habitat is not designated for blue whales. Blue whales in the western North Atlantic are classified as a single stock (NOAA Fisheries 2015c). They migrate seasonally though some sub-populations remain in certain areas year-round, though this is not reporting from the Gulf of Mexico where there are few sightings of blue whales. Information about distribution and movement varies with location, and migratory routes are not well known. In general, distribution is driven largely by food requirements and blue whales occur in waters where krill is concentrated. They are known in the Gulf of Mexico largely from strandings. There is no resident stock of blue whales considered to occur in the Gulf of Mexico.

Humpback Whale

Humpback whales are listed as endangered under the ESA and depleted under the MMPA. Critical habitat has not been designated for humpback whales. Humpback whales are distributed worldwide in all major oceans and most seas (NOAA Fisheries 2015d). They typically are found during the summer on high-latitude feeding grounds and during the winter in the tropics and subtropics around islands, over shallow banks, and along continental coasts, where calving occurs. Most humpback whale sightings are in nearshore and continental shelf waters; however, humpback whales frequently travel through deep oceanic waters during migration (Calambokidis et al. 2001). There is no resident stock of humpbacks considered to occur in the Gulf of Mexico, animals sighted are likely from the California-Oregon-Washington stock that that winters in coastal Central America and Mexico and migrates to areas ranging from the coast of California to southern British Columbia in summer/fall (NOAA Fisheries 2015e).

North Atlantic Right Whale

The North Atlantic right whale population is considered one of the most critically endangered populations of large whales in the world. They are endangered under the ESA and depleted under the MMPA. The distribution of the western stock of the northern right whale population ranges from wintering and calving grounds in coastal waters of the southeastern United States, to summer feeding and nursery grounds in New England waters (NOAA Fisheries 2015f). Records of the northern right whale in the Gulf of Mexico are considered either transient or extralimital individuals; early records may be indicative of a more extensive historical range beyond the sole known calving and wintering ground in the waters of the southeastern United States (NOAA Fisheries 2015f). There is no resident stock of right whales in the Gulf of Mexico.

Sperm Whale

Sperm whales are listed as endangered throughout their range around the world (NOAA Fisheries 2015g) and are depleted under the MMPA. Critical habitat has not been designated for sperm whales. They are the largest of the toothed whales and spend most of their time in very deep waters (1,000 m or greater), feeding primarily on large squid, sharks, skates, and rays that live in deep oceanic waters. The sperm whale is the only large whale considered to be common in the northern Gulf of Mexico with consistent sightings and satellite tracks that indicate sperm whale presence in the northern Gulf of Mexico throughout the year (Waring et al. 2015). One of the three U.S. stocks of sperm whales are known from the Gulf of Mexico (NOAA Fisheries 2015g) where they are the most abundant large cetacean in the Gulf. Sperm whales are found in the waters of the Gulf of Mexico throughout the year, through are most common during summer (NOAA Fisheries 2015g). Sightings, strandings, and sperm whale bycatch numbers are consistent enough to indicate that there may be a distinct resident group of sperm whales in the Gulf of Mexico. It is likely that there is a resident population of female sperm whales in the Gulf of Mexico since females are frequently sighted with calves (NOAA Fisheries 2012a). While they may be encountered almost anywhere inshore or offshore, sperm whale distribution in the Gulf of Mexico is generally related to the distribution of prey, and they show a preference for continental margins, sea mounts, and areas of upwelling where food is abundant (BOEM 2011a). Sperm whales are known to inhabit areas with water depths of 600 m or more and are uncommon at depths shallower than 300 m (BOEM 2011a); however, their range does extend throughout all shallow and deep waters of the Gulf of Mexico. Due to the shallow location of the proposed Port location, the presence of sperm whales would be unlikely within proposed Project waters but they are highly likely to occur in the proposed Project approaches through U.S. EEZ waters.

Bryde's Whale

Unlike other baleen whale species, Bryde's whales are restricted to tropical and subtropical waters and do not generally occur beyond latitude 40 degrees in either the northern or southern hemisphere (Jefferson et al. 2008; Kato and Perrin 2008). The primary range of Bryde's whales in the Atlantic is in tropical waters south of the Caribbean except for whales from the Gulf of Mexico, where this species is thought to be the most common baleen whale (Würsig et al. 2000). They may range as far north as Virginia (Kato and Perrin 2008). In the Gulf of Mexico, there have been many Bryde's whales sightings including near the shelf break in DeSoto Canyon (Davis et al. 2000; Davis and Fargion 1996; Jefferson and Schiro 1997). Most of the sighting records of Bryde's whales in the northern Gulf of Mexico (i.e., U.S. Gulf of Mexico) are from NOAA Fisheries abundance surveys, which have been conducted in the spring. However, there are stranding records from throughout the year (Würsig et al. 2000). There are insufficient data to assess population trends for this species (Waring et al. 2015). Due to the shallow location of the proposed Port Location, the presence of Bryde's whales would be unlikely within proposed Project waters but would be expected in the proposed Project approaches through U.S. EEZ waters.

3.3.5.2 Sea Turtles

All species of sea turtles are highly migratory and have wide geographic ranges. Five species of sea turtles occur in the Gulf of Mexico as shown in Table 3.3-1, and all of these are ESA-listed as either threatened or endangered (NOAA Fisheries 2012a). Table 3.3-2 additionally gives the likelihood of hatchlings for each species. Any of the following species of sea turtles may occur in either the nearshore or offshore waters of the northern Gulf of Mexico: the ESA-listed endangered Kemp's ridley, the ESA-listed threatened loggerhead (Northwest Atlantic Ocean DPS), the ESA-listed endangered hawksbill (*Eretmochelys imbricata*), ESA-listed threatened green (*Chelonia mydas*), and ESA-listed threatened leatherback (*Dermochelys coriacea*) (Table 3.3-2) (NOAA Fisheries 2012a).

There are four developmental stages in a sea turtle's life: egg, hatchling, juvenile, sub-adult, adult (BOEM 2011a). Hatchling turtles move immediately from beach nests to the sea after hatching. In shallower nearshore waters, sea turtles are more common because foraging areas off nesting beaches are especially important for juveniles (nesting usually occurs between May and October) (NOAA Fisheries 2012a). Eventually, most species of hatchling turtles elect to stay near floating *Sargassum* mats, moving passively through the large ocean current systems before maturing into juveniles and adults that can be found actively swimming in nearshore and open ocean areas (BOEM 2011a).

Table 3.3-2. Endangered Species Act–Listed Sea Turtle Species in the Northern Gulf of Mexico

Species	Northern Gulf of Mexico Population ESA Status	Hatchlings Potentially Present
Loggerhead turtle (*Caretta caretta*)	Threatened	Yes
Green turtle (*Chelonia mydas*)	Threatened	Yes
Hawksbill turtle (*Eretmochelys imbricata*)	Endangered	Yes
Kemp's ridley turtle (*Lepidochelys kempi*)	Endangered	Yes
Leatherback turtle (*Dermochelys coriacea*)	Endangered	Yes

Key:
ESA = Endangered Species Act
Sources: BOEM (2011a); NOAA Fisheries (2015h)

Loggerhead Sea Turtle

Loggerhead sea turtles are divided into DPSs for ESA-listing purposes. The loggerheads found in the northern Gulf of Mexico are part of the Northwest Atlantic Ocean DPS, which is listed as threatened. Critical habitat for the loggerhead Northwest Atlantic Ocean DPS was established in July 2014 in the nearshore areas of the Atlantic Ocean and the Gulf of Mexico (NOAA Fisheries 2015i). Of the critical habitats for loggerhead turtles identified by the NOAA Fisheries Southeast Regional Office (SERO; NOAA Fisheries SERO 2014), the proposed Port location would only fall within the *Sargassum* critical habitat marine area for the loggerhead (Figure 3.3-1). The proposed Port location potentially supports the primary constituent elements for loggerhead *Sargassum* habitat, including:

- Convergence zones, surface-water, downwelling areas, the margins of major boundary currents, and other locations of *Sargassum*;
- *Sargassum* in concentrations that support adequate prey abundance and cover;
- Available prey and other material associated with *Sargassum* habitat including, but not limited to, plants and cyanobacteria and animals native to the *Sargassum* community such as hydroids and copepods; and
- Sufficient water depth and proximity to available currents to ensure offshore transport (out of the surf zone), and foraging and cover requirements by *Sargassum* for post-hatchling loggerheads, i.e. greater than 10 meters depth.

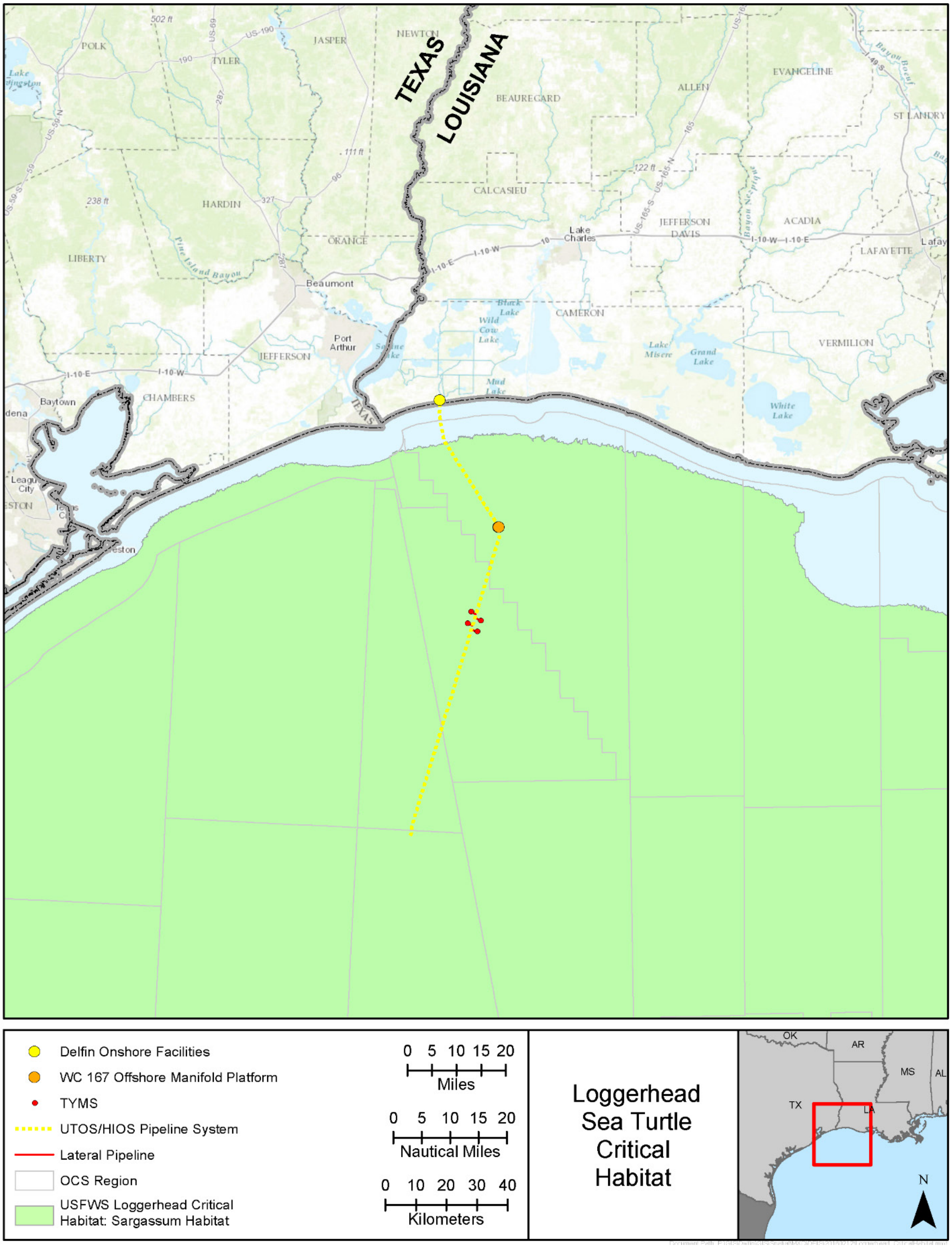


Figure 3.3-1. Loggerhead Sea Turtle Critical Habitat

Sargassum habitat (see Section 3.3.9) has been determined to be developmental and foraging habitat for young loggerheads where surface waters form accumulations of floating material, especially *Sargassum*. The presence of *Sargassum* concentrations provides these species with a substrate, protection against predation, and concentration of food in the open Gulf of Mexico (GMFMC 2004). *Sargassum* mats potentially constitute a refuge for young sea turtles that drift with these floating ecosystems as they feed off associated forage organisms (Mellgren et al. 1994; Mellgren and Mann 1996).

Green Sea Turtle

In Atlantic Ocean and Gulf of Mexico waters, green sea turtles are found in inshore and nearshore waters from Texas to Massachusetts, with important feeding areas located along coastal Florida (NOAA Fisheries 2015b). In its final rule, as of April 6, 2016 (81 FR 20057), NOAA has identified 11 DPSs for the green sea turtle (North Atlantic, Mediterranean, South Atlantic, Southwest Indian, North Indian, East Indian-West Pacific, Central West Pacific, Southwest Pacific, Central South Pacific, Central North Pacific, and East Pacific). The largest of the sea turtles, green sea turtles are unique in that they only eat plants consisting mainly of seagrasses and algae (NOAA Fisheries 2015j). In the United States, the green sea turtle is listed as threatened for the North Atlantic DPS (which includes the Gulf of Mexico and breeding populations in Florida; 81 FR 20057). The only designated critical habitat for this species is located in Puerto Rico.

Hawksbill Sea Turtle

The hawksbill is listed as endangered throughout its range around the world (NOAA Fisheries 2015k). Hawksbills are mostly associated with healthy coral reef systems, feeding on sponges and other invertebrates. Coral reefs provide shelter and food sources for this species. Within the continental United States, hawksbill turtles are found primarily in waters offshore of Florida and Texas, although they have been recorded along all the Gulf of Mexico states. Critical habitat was established in 1988 for this species only in Puerto Rico, nowhere near the proposed Port location or Project EEZ water (NOAA Fisheries 2015k).

Kemp's Ridley Sea Turtle

The smallest marine turtle in the world, Kemp's ridley sea turtles are listed as endangered throughout their entire range (NOAA Fisheries 2015l). This species primarily occupies muddy or sandy oceanic bottom habitats where the feed on crabs, fish, jellyfish, and mollusks (NOAA Fisheries 2015l). They are distributed throughout the Gulf of Mexico and the Atlantic seaboard. There is currently no designated critical habitat for this species.

Leatherback Sea Turtle

Leatherback turtles are listed as endangered throughout their range, spending most of their lives at sea in the open ocean; however, they can be found in nearshore waters when they are migrating to the shore to nest and forage. This species is the most migratory and wide ranging of the sea turtles (NOAA Fisheries 2015m). The largest marine turtle, leatherbacks have a soft body (no hard bony shell) and feed primarily on jellyfish and salps (NOAA Fisheries 2015m). Leatherbacks are able to withstand a wide range of ocean water temperatures and have been sighted along the entire U.S. east coast and into the Gulf of Mexico. Critical habitat is designated on the west coast of the United States and in the Virgin Islands and this species is not anywhere near the proposed Port location or Project EEZ water (NOAA Fisheries 2015m).

3.3.5.3 Birds

ESA-listed bird species are addressed in Section 3.12.5.1.

3.3.5.4 Fish

The Federally endangered Gulf sturgeon (*Acipenser oxyrinchus*) occurs in nearshore Gulf of Mexico waters off of Louisiana and Texas during winter months (NOAA Fisheries 2012a). Also within these nearshore waters, the Federally endangered smalltooth sawfish (*Pristis pectinate*) was historically known to occur (NOAA Fisheries 2012a). Additional details of these fish species are provided below.

Gulf Sturgeon

The Gulf sturgeon is an anadromous fish that resides in rivers in the spring and summer and in the nearshore ocean waters in the winter, and is listed as threatened throughout its range (NOAA Fisheries 2012a). In the Gulf of Mexico, the Gulf sturgeon inhabits coastal rivers from Louisiana to Florida during the warmer months, and the near shore waters of the northern Gulf of Mexico and its estuaries and bays in the cooler months (NOAA Fisheries 2015n). The Gulf sturgeon is a bottom feeder and eats primarily brachiopods, mollusks, worms, and crustaceans; all foraging occurs in brackish or marine waters of the Gulf of Mexico and its estuaries, sturgeon do not forage in riverine habitat (NOAA Fisheries 2015n). In 2003, Gulf sturgeon critical habitat was designated in 14 geographic areas from Florida to Louisiana, encompassing spawning rivers and adjacent estuarine areas (Figure 3.3-2) (NOAA Fisheries 2015n). The proposed Project does not fall within this critical habitat, and this species is not expected to occur in the proposed Project vicinity.

Smalltooth Sawfish

Sawfish, like sharks, skates, and rays, are cartilaginous elasmobranchs. Sawfish species inhabit shallow coastal waters of tropical seas and estuaries throughout the world. The smalltooth sawfish is found in coastal areas near estuaries with larger animals occurring farther offshore, and is listed as endangered under the ESA throughout its range (NOAA Fisheries 2012a). Often found in sheltered bays, in estuaries, or river mouths, the smalltooth sawfish primarily inhabits shallow coastal waters less than 32 ft, close to shore over muddy and sandy bottoms (NOAA Fisheries 2015o). In the United States, the population was historically common throughout the Gulf of Mexico from Texas to Florida, and along the east coast from Florida to North Carolina. The smalltooth sawfish is currently found only along the peninsula of Florida in the Atlantic, common only in the Everglades region at the southern tip of the State. However, this species was once common throughout its historic range but has declined dramatically in United States waters over the last century. Critical habitat for the United States DPS was established in September 2009 and is located along the Florida peninsula and keys, nowhere near the proposed Project (NOAA Fisheries 2015o). This species is not expected to occur within the vicinity of the proposed Project.

3.3.6 Marine Protected Areas

Many areas of the marine environment in the United States have some level of Federal, State, or local management or protection. MPAs have conservation or management purposes, defined boundaries, and some legal authority to protect resources. Nationally, MPAs are defined in EO 13158, *Marine Protected Areas*, as "any area of the marine environment that has been reserved by federal, state, territorial, tribal, or local laws or regulations to provide lasting protection for part or all of the natural and cultural resources therein."

The National Marine Protected Area Center developed a MPA classification system that provides definitions and qualifications for the various terms within EO 13158. The system uses six functional criteria to objectively describe the key features of most marine protected areas:

1. Primary conservation focus (e.g., natural heritage, cultural heritage, or sustainable production);
2. Level of protection (e.g., no access, no impact, no take, zoned with no-take areas, zoned multiple use, or uniform multiple use);
3. Permanence of protection;
4. Constancy of protection;
5. Ecological scale of protection; and
6. Restrictions on extraction.

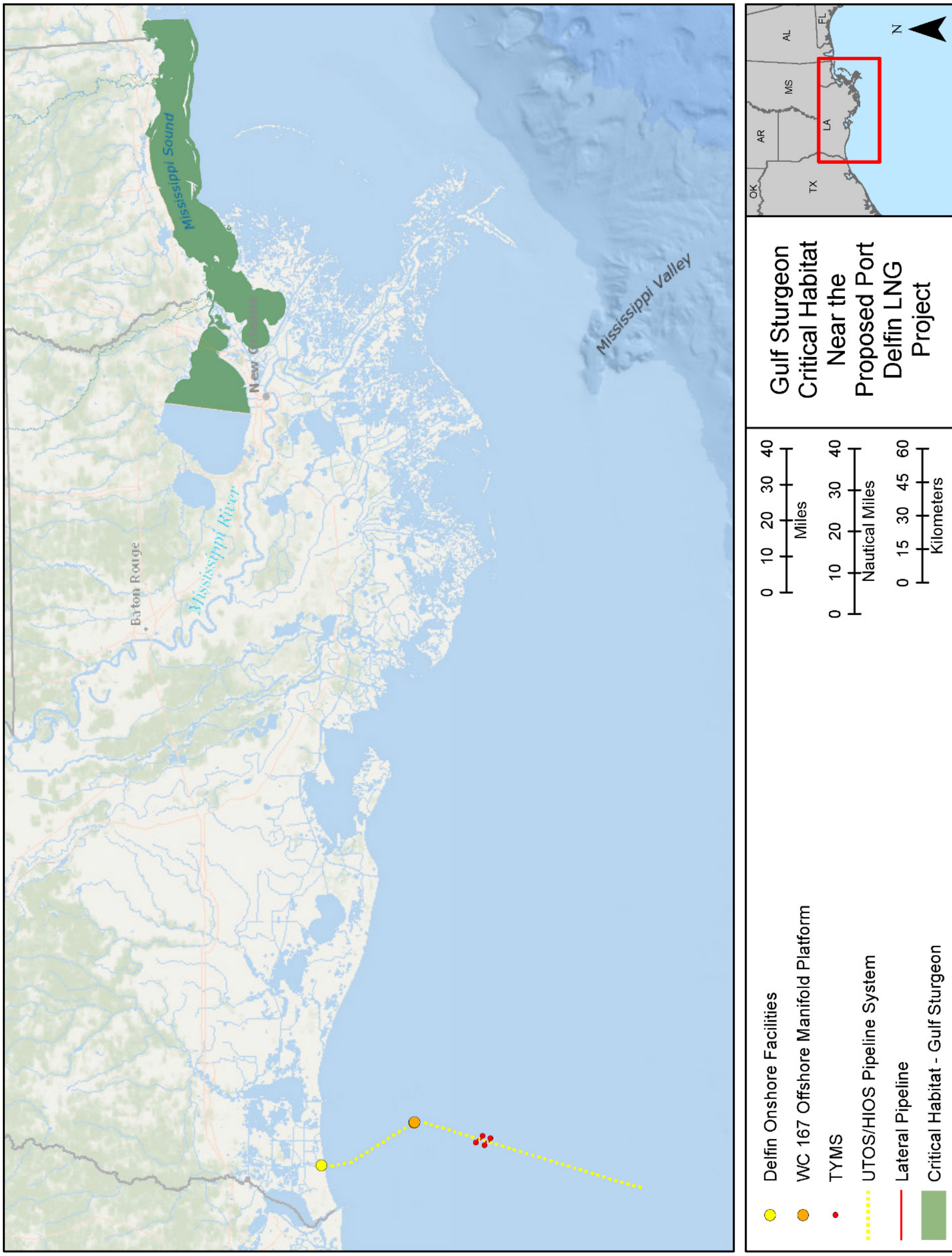


Figure 3.3-2. Gulf Sturgeon Critical Habitat Near the Proposed Port Delfin LNG Project

MPAs cover more than 40 percent of U.S. marine waters. MPAs are designated and managed at all levels of government by a variety of agencies and have been established by more than 100 legal authorities. MPAs vary widely in purpose, legal authorities, managing agencies, management approaches, level of protection, and restrictions on human uses. They have been designated to achieve objectives ranging from the conservation of biodiversity, to the preservation of sunken historic vessels, to the protection of spawning species important to commercial and recreational fisheries. The levels of protection provided by these MPAs range from fully protected (i.e., no-take) reserves to sites allowing multiple uses including fishing, recreation, and industrial uses.

Coastal states and territories manage approximately 75 percent of the MPAs, most of which are typically quite small and comprise about 2 percent of the MPA surface area coverage.

As shown in Figure 3.3-3, the existing U-T Offshore System (UTOS)/HIOS pipeline systems, the proposed WC 167 bypass, and the proposed Port and pipeline laterals are located within Reef Fish Longline and Buoy Gear Restricted Area. The existing UTOS/HIOS pipeline systems and the proposed WC 167 bypass are also located within the Reef Fish Stressed Area. These MPAs were established to encourage sustainable production along the Gulf of Mexico coast. The only protective measures in place in these MPAs are related to gear and seasonal restrictions for fishing (50 Code of Federal Regulations [CFR] 622.35).

The closest MPA to the proposed Port is the Flower Garden Banks National Marine Sanctuary (FGB NMS) and it is approximately 132 miles to the south-southwest. The FGB NMS was established in 1992 in the northwestern portion of the Gulf of Mexico Large Marine Ecosystem, nearly 96 nautical miles (177 km) off the coast of Texas and Louisiana. The sanctuary encompasses 42 square nautical miles (145 km^2) in three separate areas: East Flower Garden, West Flower Garden, and Stetson Banks. Stetson Bank, which was added to the FGB NMS in 1996, is located mid-shelf, 30 miles (48 km) northwest of the Flower Garden Banks.

3.3.7 Marine Mammals

The number of marine mammal species known from the Gulf of Mexico varies depending on the source document. Summary lists range from 21 marine mammals (Waring et al. 2015) to 27 (Jefferson and Shiro 1997) to 30 (Wursig et al. 2000). Some of the existing variation is due to certain authors counting extralimital species or transients as potentially occurring, or due to variations in occurrences of the many beaked whale species considered to occur. Regardless of these variations, only 2 species are common enough to be considered regularly occurring species in waters of the proposed Port location—the Atlantic spotted dolphin (*Stenella frontalis*) and the bottlenose dolphin (*Tursiops truncatus;* multiple stocks) (Table 3.3-1), and 2 others are unlikely but remotely possible (sperm whale [*Physeter microcephalus*] and Bryde's whale [*Balaenoptera edeni*]). The sperm whale is an ESA-listed species and is addressed in Section 3.3.5.1. The Gulf of Mexico DPS of Bryde's whale is a candidate species for ESA listing (80 FR 18343) and is also addressed in Section 3.3.5.1. ESA-listed marine mammals in the northern Gulf of Mexico EEZ include other large whale species, addressed in Section 3.3.5.1. These would not be expected in the proposed Port location.

Atlantic Spotted Dolphin

Atlantic spotted dolphins occur throughout the warm temperate, subtropical, and tropical waters of the Atlantic Ocean (NOAA Fisheries 2015p). They have a widespread distribution that ranges from the U.S. East Coast (Gulf of Mexico to Cape Cod, Massachusetts), the Azores, and Canary Islands to Gabon and Brazil. Their distribution may be affected by warm currents such as the Gulf Stream. In the waters of the northern Gulf of Mexico, this species is usually observed within the shelf waters from 10 to 200 m deep out to deeper slope waters around 500 m deep (Waring et al. 2015). Atlantic spotted dolphins are usually found in groups of fewer than 50 individuals but have been occasionally seen in larger groups of around 200 animals.

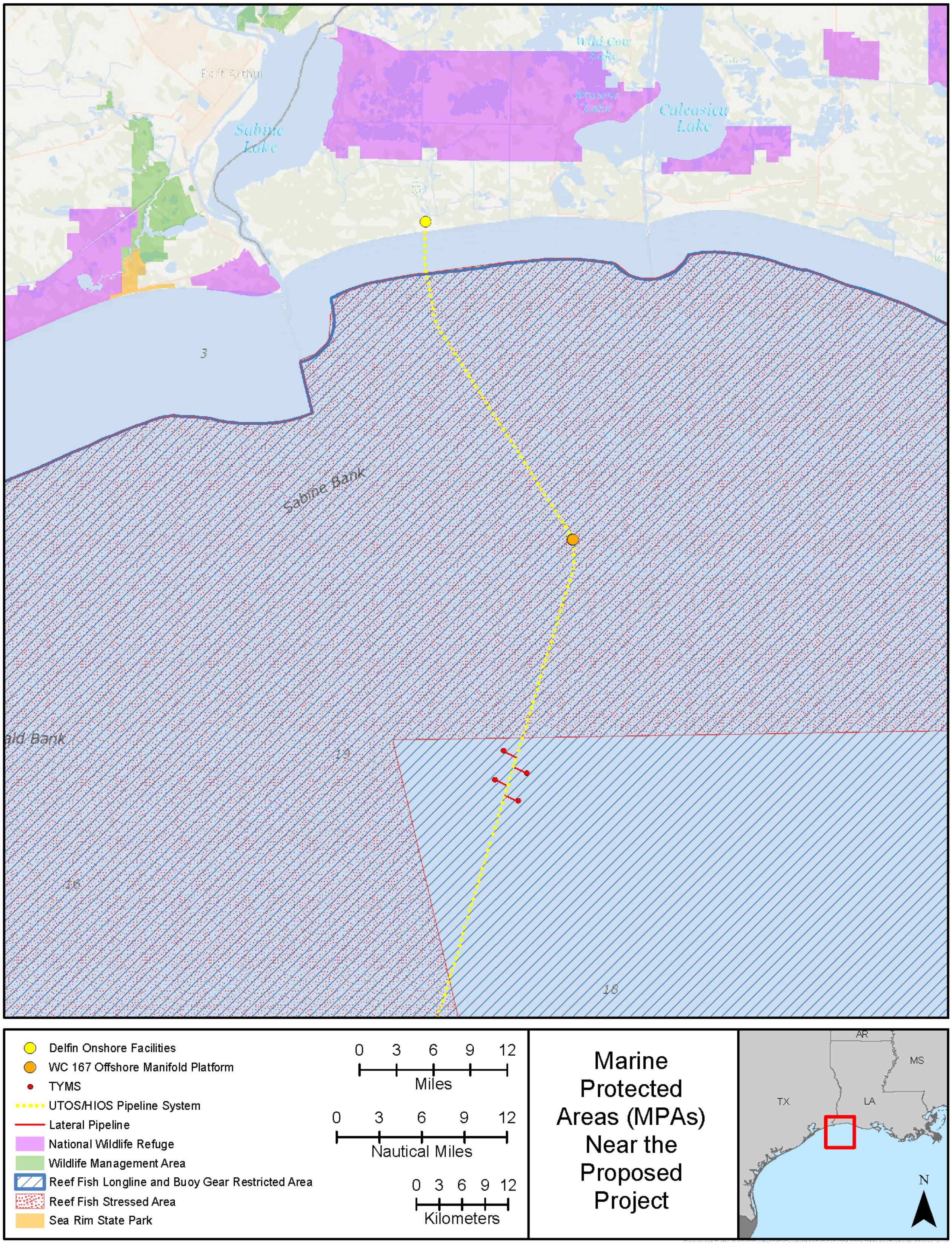


Figure 3.3-3. Marine Protected Areas (MPAs) Near the Proposed Project

Bottlenose Dolphin

The bottlenose dolphin is found in oceanic waters worldwide, ranging from latitudes of 45°N to 45°S and is divided into different stocks in the Gulf of Mexico for management purposes (Waring et al. 2015). There are coastal populations that migrate into bays, estuaries and river mouths as well as offshore populations that inhabit pelagic waters along the continental shelf (NOAA Fisheries 2015q). The coastal stocks are found generally throughout shallower nearshore waters out to 66 ft, or around 56 miles from shore in the northern Gulf of Mexico (Waring et al. 2015).

3.3.8 Coastal, Marine, and Migratory Birds

Federally listed and State-listed species with ranges that may overlap the proposed DOF and adjacent region are listed in Section 3.12.5.

Birds protected by the MBTA as mentioned in Section 3.12.7 are anticipated to occur and may breed within the proposed Project area. A search was conducted in the USFWS's Information, Planning, and Conservation System (USFWS IPaC 2015) for migratory birds that could occur at the proposed Port. Species were then examined for nesting range, nesting season, nesting habitat, and potential to occur at the proposed Project area.

As part of the agency consultation process on the proposed Project, including the proposed DOF under the Commission's jurisdiction, on March 2, 2015, Delfin LNG sent a letter providing details on the proposed Project to the USFWS Louisiana Ecological Services Office located in Lafayette, Louisiana. The USFWS provided a response on March 17, 2015, requesting that the proposed Project evaluate potential impacts on the following bird species under agency jurisdiction:

- piping plover (ESA Threatened),
- red knot (ESA Threatened), and
- migratory birds (under the MBTA).

ESA-listed bird species are addressed in Section 3.12.5.1. The Gulf of Mexico is an extremely important pathway for migratory birds, including many coastal and marine species that utilize the coastlines of Louisiana and eastern Texas along their migratory routes (BOEM 2011a). Migratory birds are known to sometimes utilize offshore structures associated with oil and gas platforms as rest stops or temporary shelter during their migrations. Some of the most extensively used migratory routes are known to be located in the airspace above the location of the proposed Project. The MBTA of 1918 (16 U.S.C. 703-712) affirms, or implements, the U.S.'s commitment to four international conventions (with Canada, Japan, Mexico, and Russia) for the protection of a shared migratory bird resource. The MBTA protects species or families of birds that live, reproduce, or migrate within or across international borders at some point in their life cycle. Unless permitted by regulations, all native migratory birds are protected under the MBTA (OLRC 2015). The limitation to the species protected by the MBTA applies only to migratory bird species that are native to the United States or its territories. Native refers to a bird species that occur in the United States or its territories solely as a result of intentional or unintentional human-assisted introduction. A bird species would also not be considered native to the United States or its territories unless it was native to the United States or its territories and extant in 1918; it was extirpated after 1918 throughout its range in the United States and its territories; and after such extirpation, it was reintroduced in the United States or its territories as part of a program carried out by a Federal agency. Thus, all of the native migratory bird species likely to occur within the proposed Port and adjacent offshore, nearshore, and onshore areas are protected by the MBTA.

More than 400 species of birds have been reported in the northern Gulf of Mexico (BOEM 2011a). Many bird species, such as the brown pelican, may be found in more than one of the five Gulf of Mexico states, while a much smaller subset are largely restricted to a particular state or local area (BOEM 2011a). The majority of bird species found in the northern Gulf of Mexico are known to reside primarily in interior or coastal beach and wetland habitats, not over open ocean environments where the proposed Project would be located.

Seabird ranges are variously defined using categories such as "nearshore (onshore from the coast out to 5 miles [8 km])." These birds generally occur from estuarine waters out to the shelf edge. Offshore birds generally are greater than 5 miles (8 km) off the coast, and pelagic birds are defined as occurring in waters deeper than 590 ft (180 m). The majority of northern Gulf of Mexico birds are nearshore or onshore waterbird species, many of which are also likely to be sighted nearshore though possibly offshore (for example, the brown pelican could forage as far offshore as the proposed Port area). This is relatively unlikely, and therefore the brown pelican is treated as an onshore bird (see Section 3.12.7).

Other species of seabirds that migrate can be found within the Gulf of Mexico region seasonally, or in offshore or pelagic habitats of the Gulf of Mexico (e.g., boobies, petrels, and shearwaters). These birds would be considered transients in the area and not likely to occur with any regular frequency especially because the proposed Port footprint is not in waters of that depth.

MBTA avian species that may occur offshore are shown in Table 3.3-3. Note that many of the species listed are seasonal or rare. Some of the more common species include the brown booby (*Sula leucogaster*) and skua (*Stercorarius* spp.). Skuas were the most common bird seen in autumn in offshore areas, and skuas and gulls (*Larus* spp.) are the most common in winter (Ribic et al. 1997). Terns (*Sterna* spp.) are the most common birds seen in late summer. Other species with seasonal presence include petrel species (Wilson's storm-petrel [*Oceanites oceanicus*] April-Nov.; band-rumped storm-petrel [*Oceanodroma castro*] April-Sept. (late May-early Aug. best); Leach's storm-petrel [*Oceanodroma leucorhoa*] May-Sept.), and shearwater species (Cory's shearwater [*Calonectris diomedea*] June-Nov.; and Audubon's shearwater [*Puffinus lherminier*] April-Nov.).

Table 3.3-3. Gulf of Mexico Seabird Summary

Common Name	Species Name	Season
Yellow-nosed Albatross	*Thalassarche chlororhynchos*	Accidental; two Texas records
White-chinned Petrel	*Procellaria aequinoctialis*	Accidental; one Texas record
Sooty Shearwater	*Puffinus griseus*	Rare throughout the year
Cory's Shearwater	*Calonectris diomedea*	June-Nov.; locally common Sept.-Oct.
Greater Shearwater	*Puffinus gravis*	Rare throughout the year
Manx Shearwater	*Puffinus puffinus*	Very rare; five Texas records
Audubon's Shearwater	*Puffinus lherminieri*	April-Nov.; rare remainder of year
Black-capped Petrel	*Pterodroma hasitata*	Very rare
Wilson's Storm-Petrel	*Oceanites oceanicus*	April-Nov.; rare remainder of year
Band-rumped Storm-Petrel	*Oceanodroma castro*	April-Sept. (late May-early Aug. best)
Leach's Storm-Petrel	*Oceanodroma leucorhoa*	May-Sept.
Red-billed Tropicbird	*Phaethon aethereus*	Very rare
White-tailed Tropicbird	*Phaethon lepturus*	Rare except in Dry Tortugas area
Magnificent Frigatebird	*Fregata magnificens*	Locally abundant April-Nov.; rare remainder of year
Northern Gannet	*Morus bassanus*	Locally abundant April-Nov.; rare remainder of year
Brown Booby	*Sula leucogaster*	Very throughout the year
Red-footed Booby	*Sula sula*	Very rare spring
Masked Booby	*Sula dactylatra*	Uncommon April-May, Oct.-Nov.; common June-Sept.

Table 3.3-3. Gulf of Mexico Seabird Summary (continued)

Common Name	Species Name	Season
Blue-footed Booby	*Sula nebouxii*	Accidental
Red-necked Phalarope	*Phalaropus lobatus*	Uncommon migrant, season uncertain
Red Phalarope	*Phalaropus fulicarius*	Rare migrant, season uncertain
Pomarine Jaeger	*Stercorarius pomarinus*	Very common Nov.-Mar.; uncommon April-May, Aug.-Oct.
Parasitic Jaeger	*Stercorarius parasiticus*	Possibly locally common, status uncertain
Long-tailed Jaeger	*Stercorarius longicaudus*	Rare spring and fall
Laughing Gull	*Larus atricilla*	Abundant year round
Franklin's Gull	*Larus pipixcan*	Western Gulf spring and fall, nearshore
Bonaparte's Gull	*Chroicoloeus philadelphia*	Common winter
Ring-billed Gull	*Larus delawarensis*	Common winter
Herring Gull	*Larus argentatus*	Common winter
Black-legged Kittiwake	*Rissa tridactyla*	Rare winter
Gull-billed Tern	*Gelochelidon nilotica*	Common spring-fall nearshore
Royal Tern	*Thalasseus maxima*	Abundant year round nearshore
Sandwich Tern	*Thalasseus sandvicensis*	Locally abundant nearshore spring-fall
Common Tern	*Sterna hirundo*	Common spring and fall; uncommon summer
Arctic Tern	*Sterna paradisaea*	Very rare spring
Roseate Tern	*Sterna dougallii*	Very rare except near Dry Tortugas
Forster's Tern	*Sterna forsteri*	Abundant year round nearshore
Least Tern	*Sternula antillarum*	Common March-Nov. nearshore
Bridled Tern	*Onychoprion anaethetus*	Common April-Oct.; rare Nov.-March
Sooty Tern	*Onychoprion fuscata*	Locally common year round
Black Tern	*Chlidonias niger)*	Abundant April-Oct.
Brown Noddy	*Anous stolidus*	Very rare except near Dry Tortugas
Black Skimmer	*Rynchops niger*	Common year round nearshore
Source: Peake and Elwonger (1996)		

3.3.9 Marine Vegetative Communities

Sargassum is a brown alga (*Sargassum natans* and *S. fluitans*) that is free-floating and forms dense mats in tropical Atlantic waters and the Gulf of Mexico. Pelagic *Sargassum* supports a diverse assemblage of marine organisms, including hydroids, copepods, fish, crab, gastropods, polychaetes, anemones, sea spiders, stages of sea turtles, and numerous marine birds (SAFMC 2002). *Sargassum* concentration is high in areas of convergence zones, surface-water downwelling areas, and the margins of major boundary currents. In the Gulf of Mexico, downwelling *Sargassum* areas occur close to the shore (Bortone et al. 1977; Gower and King 2011). Distribution and movement of pelagic *Sargassum* in the Gulf of Mexico and western Atlantic Ocean exhibits a temporal pattern from year to year, typically with higher concentrations in the northwest Gulf of Mexico from March to June, then spreading eastward into the central and eastern Gulf of Mexico (Gower and King 2011). After September, few concentrations are present in the Gulf of Mexico (Gower and King 2011).

Marine organisms encounter *Sargassum* as it drifts with the current through the Gulf of Mexico. Shrimp, crab, and plankton associated with *Sargassum* concentrations become a major source of food for associated fish. The planktonic community associated with *Sargassum* concentrations has been found to be more productive than the surrounding waters, and potential food resources for higher order organisms, such as sea turtles, are in greater abundance than the surrounding waters (Richardson and McGillivary 1991). *Sargassum* acts as the vehicle for dispersal of some of its inhabitants and might be important in the life histories of many species of fish and sea turtles. The presence of *Sargassum* concentrations provides these species with a substrate, protection against predation, and concentration of food in the open Gulf of Mexico (GMFMC 2004). *Sargassum* mats potentially constitute a refuge for young sea turtles that drift with these floating ecosystems as they feed off associated forage organisms (Mellgren et al. 1994; Mellgren and Mann 1996). The most abundant fish species associated with *Sargassum* mats in the northwestern Gulf of Mexico include planehead filefish (*Monacanthus hispidus*), blue runner (*Caranx crysos*), gray triggerfish (*Balistes capriscus*), chain pipefish *(Syngnathus louisianae*), sergeant major (*Abudefduf saxatilis*), sargassum fish (*Histrio histrio*), and greater amberjack (*Seriola dumerili*) (Wells and Rooker 2004).

Given the importance of *Sargassum* habitat, critical habitat for the loggerhead Northwest Atlantic Ocean DPS was established in July 2014 in the nearshore areas of the Atlantic Ocean and the Gulf of Mexico (NOAA Fisheries 2015i). As indicated in Section 3.3.5.2 and Figure 3.3-1, the proposed Port location would fall within the *Sargassum* critical habitat marine area for the loggerhead.

3.3.10 Benthic Resources

Offshore habitat in the northern Gulf of Mexico includes soft-bottom, intermittent areas of hard (live) bottom, and artificial reefs. No hard-bottom or live-bottom habitat is known or believed to occur in the vicinity of the proposed Port, based on maps prepared by BOEM guide to oil and gas exploration and development. BOEM's Programmatic EIS for Lease Sales in the BOEM-designated WC area, where the proposed Port is located, shows the nearest substantial hard-bottom habitat to be more than 100 miles offshore, well out of range of impacts relating to the proposed Port (Figure 3.3-4). These data are compiled for use in the BOEM Topographic Features Banks, Live-Bottom (Pinnacle Trend Features), and Live Bottom (Low Relief Features) Stipulations (BOEM lease-mandated conservation measures) which prohibit bottom-disturbing activity in sensitive, live-bottom, offshore habitats, which are considered essential fish habitat (EFH; see Section 3.4), by excluding structures, drilling, pipelines, and production activities on or near high-relief and low-relief hard-bottom areas.

Benthic communities serve as trophic links between plankton and higher-order consumers because they feed on plankton and detritus, and are preyed upon by fishes and larger invertebrates. In addition, benthic organisms provide physical substrate that adds complexity to soft bottom habitat. The soft, muddy bottom supports two dominant groups of benthic fauna: (1) infauna (animals that live in the substrate, such as burrowing worms, crustaceans, and mollusks) and (2) epifauna (animals closely associated with the substrate, such as crustaceans, echinoderms, mollusks, hydroids, sponges, and soft and hard corals).

In the subtidal Gulf, benthic habitats are also highly productive, although less conspicuously so than tidal marshes (Britton and Morton 1989). The offshore food chain is anchored by phytoplankton, notably diatoms, dinoflagellates, and other unicellular algae. Infaunal suspension feeders such as bivalve mollusks consume either plankton, sediment, or both. The numerically dominant polychaetes, or soft-bodied segmented worms, are represented by species that feed by ingesting sediment, pursuing prey, scavenging, or selectively collecting detritus. In turn, this wide variety of infaunal organisms are eaten by predatory gastropods (the familiar "sea shells"), starfish, decapod crustaceans (shrimp and crabs), and fish (Britton and Morton 1989).

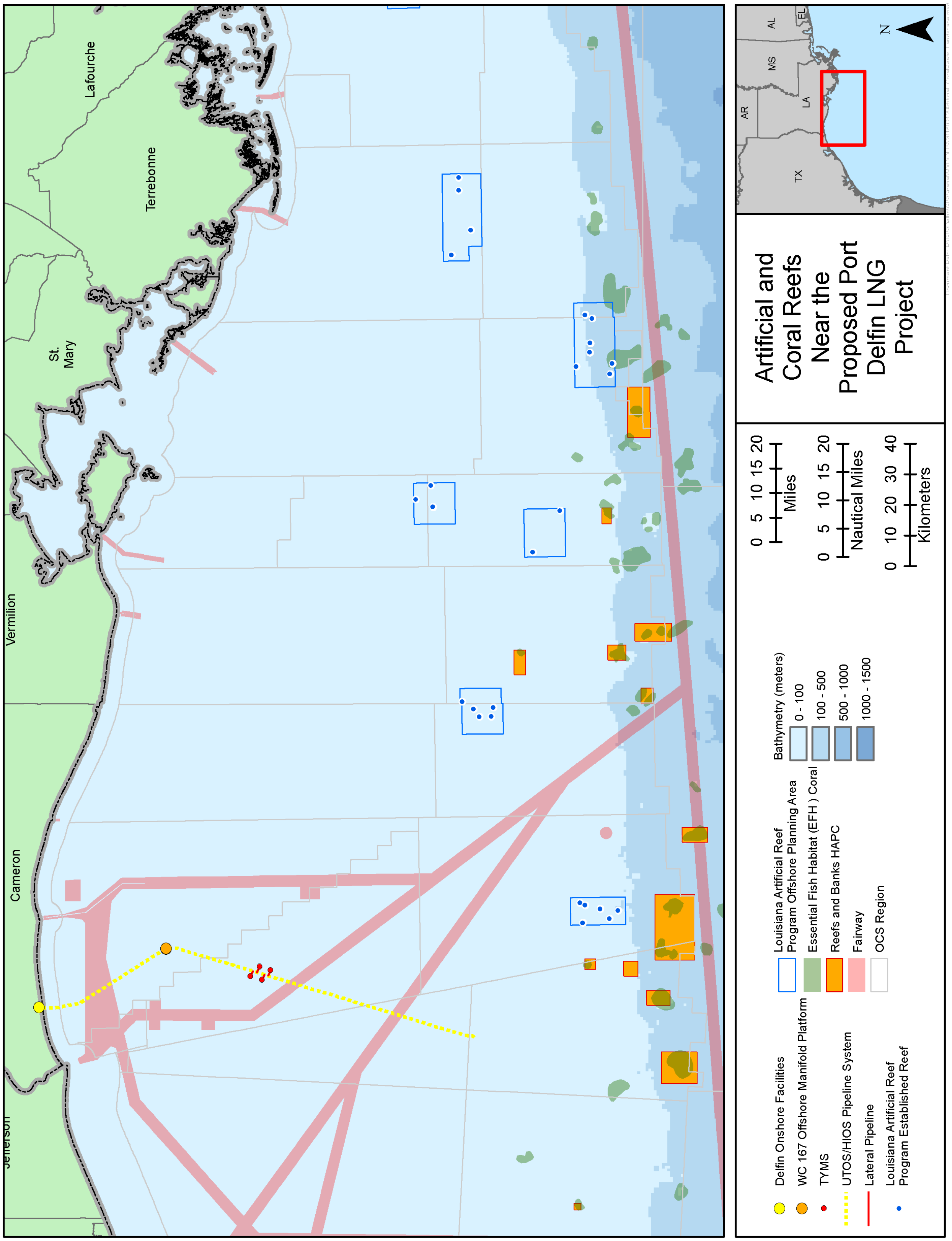


Figure 3.3-4. Artificial and Coral Reefs Near the Proposed Port Delfin LNG Project

3.3.11 Plankton

By far the most abundant organisms in the open waters of the Gulf of Mexico plankton (phytoplankton, zooplankton, and ichthyoplankton (fish and invertebrate eggs and larvae). The plankton community consists of both permanent members and transient larval forms of fishes and invertebrates (Johnson and Allen 2005). Plankton and marine invertebrates in the open waters of the Gulf of Mexico are the basis of the food web that supports fish, birds, sea turtles, and marine mammals and provides recreation and economic benefits to people. The composition of the planktonic community in any given location and depth changes over time in response to physical factors such as wind, currents, turbidity, nutrient availability, and light (Hernandez et al. 2010). Ecological processes such as predation and competition also influence the abundance and distribution of planktonic organisms. Lower trophic level communities are characterized by mixed species assemblages of phytoplankton, zooplankton, and ichthyoplankton, as well as pelagic invertebrates. These organisms are predominately moved passively within water masses, although some have limited swimming abilities.

Although most plankton are tiny, they range in size from microscopic bacteria and plants to larger animals, such as jellyfish. Zooplankton are categorized by size as the barely visible microzooplankton (20 micrometers [µm] to 0.2 millimeter [mm]) and mesozooplankton (0.2–20 mm), and the more familiar macrozooplankton (20 mm–20 cm), which includes ctenophores (comb jellyfish), shrimp, amphipods, euphausiids, and larval fish. The megazooplankton (20 cm–2 m) are the true jellyfish. Plankton are also grouped by residency in the plankton. Holoplankton remain in the plankton throughout their lives; meroplankton are temporarily planktonic during certain life stages (especially larval) and are more seasonally occurring (Britton and Morton 1989).

Phytoplankton and zooplankton provide the nutritional support for essentially all of the important species in the Gulf of Mexico. Some important fish species, such as Gulf menhaden and bay anchovy, rely on plankton food their entire lives (Patillo et al. 1997). Larval stages of virtually all of the important finfish and shellfish species consume vast amounts of plankton. Many fish that are piscivorous as adults, such as spotted seatrout and Atlantic croaker, rely on zooplankton during early life stages then shift to larger prey as they grow (Akin and Winemiller 2006). Immature stages of species that are harvested as adults, such as blue crab, are well-represented in the plankton (Lochmann et al. 1995).

Ichthyoplankton (fish and invertebrate eggs and larvae) make up a substantial portion of the zooplankton community, as most fishes in the Gulf of Mexico have pelagic larval stages (BOEM 2012a). For most Gulf of Mexico species, the larval stage last between 10 and 100 days, depending on the species. The distribution of fish larvae depends on spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, and larval mortality and growth (BOEM 2012a). For most of the year in the north-central Gulf of Mexico, density of ichthyoplankton is greater at the surface and decreases with depth (Shaw et al. 2002). Some larvae undergo daily vertical migrations in response to daylight (Shaw et al. 2002). Larval fishes are highly dependent on zooplankton until they can feed on larger prey. The composition of larval fish assemblages varies with season, mediated by temperature, day length, nutrient supply, and other factors (BOEM 2012a). In general, larval densities are lowest during winter, increase during the spring, peak during the summer, and decline during the fall, as shown in Table 3.3-4. Many of the managed fish and invertebrates are in the ROI in the spring, late spring, and early fall. From May through October, king and Spanish mackerel and many of the snappers are present.

Distribution and abundance of ichthyoplankton is a function of adult movement, spawning season, currents, and other physical and biological parameters that vary spatially and temporally. Seasonal patterns of ichthyoplankton composition in nearshore waters are strongly influenced by the spawning cycles of coastal fish species, while further offshore composition is influenced by the spawning cycles of pelagic and migratory species. The Mississippi River discharge plume and the Loop Current have widespread influence over patterns of ichthyoplankton abundance throughout the Gulf of Mexico.

Table 3.3-4. Seasonability and Peak Seasonal Occurrence of Larval Fishes (<10 mm standard length)

Family (common name)	Taxa (common name)	Scientific Name	J	F	M	A	M	J	J	A	S	O	N	D
Herring and Menhaden	Gulf menhaden	*Brevoortia patronus*	*	*	X	X					X	X	X	*
	Round herring	*Etrumeus teres*	*	*	*	X	X	X					X	X
	Atlantic thread herring	*Opisthonema oglinum*			X	X	*	*	*	*	X	X	X	
Anchovy	Striped	*Anchoa hepsetus*	X	X	*	*	*	*	*	*	*	X	X	X
	Bay	*Anchoa mitchilli*	X	X	*	*	*	*	*	*	*	X	X	X
	Longnose	*Anchoa nasuta*	X	X	*	*	*	*	*	*	*	X	X	X
Sea Bass and Grouper	Sand perch	*Diplectrum formosum*	X	X	X	X	*	*	*	*	X	X	X	X
	Pygmy sea bass	*Serraniculus pumilio*					X	*	*	*	*	X	X	
Jacks, scads, pompanos, and relatives	Blue runner	*Caranx crysos*			X	X	X	*	*	*	X	X	X	
	Atlantic bumper	*Chloroscombrus chrysurus*				X	X	*	*	*	*	X		
	Round scad	*Decapterus punctatus*			X	*	*	*	*	*	*	X	X	
	Rough scad	*Trachurus lathami*	*	*	X	X	X						X	X
	Dolphin	*Coryphaena hippurus*					X	X	X	X	X	X	X	
Snapper	Red	*Lutjanus campechanus*				X	X	*	*	*	X	X	X	
	Gray	*Lutjanus griseus*				X	X	*	*	*	X	X	X	
	Lane	*Lutjanus synagris*				X	X	*	*	*	X	X	X	
Majorras, Porgies	Pigfish	*Orthopristis chrysoptera*	X	X	*	X	X							
	Sheepshead	*Archosargus probatocephalus*	X	*	*	*	X							
	Pinfish	*Lagodon rhomboides*	*	*	X	X						X	X	*
Drums, Croakers, Seatrout	Spotted seatrout	*Cynoscion nebulosus*		X	X	*	*	*	*	*	X	X		
	Spot	*Leiostomus xanthurus*	*	X	X	X						X	X	*
	Atlantic croaker	*Micropogonias undulatus*	*	X	X	X					X	*	*	*
	Red drum	*Sciaenops ocellata*								X	*	*	X	
Spadefish	Atlantic spadefish	*Chaetodipterus faber*				X	X	*	*	*				
Mackerels, Tunas, Wahoo	Bullet mackerel	*Auxis rochei*	X	X	X	X	*	*	*	*	*	X	X	
	Little tunny	*Euthynnus alletteratus*				X	*	*	*	*	*	X	X	
	Skipjack tuna	*Euthynnus pelamis*				X	X	X	X	X	X	X		
	King mackerel	*Scomberomorus cavalla*					X	X	X	*	*	X	X	
	Spanish mackerel	*Scomberomorus maculatus*				X	X	X	X	*	*	X		
	Bluefin tuna	*Thunnus thynnus*				X	X	X						
Butterfish	Gulf butterfish	*Peprilus burti*	*	*	*	X	X	X	X	X	X	X	*	*
Key: X = Seasonality; * = Peak Seasonal Occurrence.														

Spring and fall plankton surveys have been conducted in the Gulf of Mexico since 1982 as part of NOAA's Southeast Area Monitoring and Assessment Program (SEAMAP). Plankton were collected using neuston nets and bongo nets. Ichthyoplankton abundance in the ROI was estimated using samples from a 30- by 30-nautical mile (34.5- by 34.5-statute mile; 55.5- by 55.5-km) coverage of SEAMAP sampling stations near the proposed Port location. The size and configuration of the area within which SEAMAP data are considered representative of a proposed site requires careful consideration of the SEAMAP sampling station grid, the strong cross-shelf distribution of ichthyoplankton (e.g., Ditty et al. 1988; Hernandez et al. 2002;

Shaw et al. 2002), and environmental factors, such as proximity to shore and depth of the study area. The boundary polygon defining the Delfin LNG study area was developed and further refined based on comments received during the deepwater port application process. The final ROI is a block defined by the following corner coordinates, as depicted in Figure 3.4-6: 93.27º W, 28.87º N; 93.77º W, 28.88º N; 93.23º W, 29.32º N; 93.77º W, 29.32º N.

The mean larval fish density within the ROI was 0.274 larvae/m^3, or about 1,037 larvae per million gallons (Mgal) of seawater. Mean density of fish eggs was 4.6 eggs/m^3 (17,484 eggs per Mgal). More than one dozen managed species and numerous forage species were represented in the samples (see Section 3.3.12.1 and Appendix I).

Floating *Sargassum* (also called Gulf weed) carries a variety of attached organisms, including hydroids and barnacles. In addition to the sessile community, many motile animals are strongly associated with floating *Sargassum*; a typical assemblage includes fish, crabs, gastropods, polychaetes, bryozoans, anemones, and sea spiders (Britton and Morton 1989).

3.3.12 Fisheries Resources

The northern Gulf of Mexico is one of the most productive fishery areas in North America (USEPA 2014). The Gulf of Mexico's marine habitats, ranging from coastal marshes to the deep-sea abyssal plain, support a varied and abundant faunal assemblage. Water temperature, benthic habitat, and geographic location appear to be the primary factors affecting the distribution of marine fishes in the Gulf of Mexico (Bowen and Avise 1990). The northern Gulf of Mexico inner shelf fish assemblage is discussed in terms of two broad groups: demersal and coastal pelagic fishes.

Demersal fishes are oriented physically and behaviorally toward the seafloor, and further delineated by substrate type and water depth (Gallaway 1981). The dominant fish assemblage in the proposed Project area is known as the brown shrimp assemblage because most data come from commercial trawls for valuable species. Trawl catches in this area of the Gulf of Mexico are dominated by the longspine porgy (*Stenotomus caprinus*), Mexican searobin (*Prionotus paralatus*), horned searobin (*Bellator militaris*), and dwarf goatfish (*Deneus paryus*). Juvenile red snapper (*Lutjanus campechanus*) are also abundant in trawl catches on brown shrimp grounds. Unlike the brown shrimp itself, most of the fish species taken as bycatch in offshore shrimp trawls are associated with the outer shelf rather than coastal waters and estuaries.

Coastal Pelagic Fishes inhabit the nearshore waters of the Gulf of Mexico throughout the year. Highly migratory pelagic species such as tuna and billfishes may transit through the surface waters near the proposed Project, but are not considered residents of the area. Major coastal pelagic fishes in the proposed Project area include requiem sharks (*Carcharhinidae*), ladyfish (*Elopidae*), anchovies (*Engraulidae*), herrings (*Clupeidae*), mackerels and tunas (*Scombridae*), jacks (*Carangidae*), mullets (*Mugilidae*), bluefish (*Pomatomus saltatrix*), and cobia (*Rachycentron canadum*). Some species such as the Spanish mackerel (*Scomberomorus maculatus*) form large schools, while others, such as the cobia, are less gregarious.

Planktivorous coastal pelagic fishes are typically small and shiny, with schooling tendencies, as characterized by the Gulf menhaden (*Brevoortia patronus*), Atlantic thread herring (*Opisthonema oglinum*), Spanish sardine (*Sardinella aurita*), round scad (*Decapterus punctatus*), Atlantic silverside (*Menidia menidia*)**,** and anchovies. These abundant planktivores support numerous predatory fishes, including king and Spanish mackerels, bluefish, cobia, dolphin (*Coryphaena hippurus*), jacks, and tunas. Most of the large fishes are migratory, tracking abundant prey throughout the year. The most abundant component of the fish community in open waters near the proposed Port are ichthyoplankton (see above). Buoyant eggs and larvae remain in the plankton from 10 to 100 days, depending on the species (MMS 2007).

3.3.12.1 Managed Fisheries

Marine fisheries in the proposed Project area are under primary jurisdiction of the Gulf of Mexico Fishery Management Council (GMFMC), established under authority of the Magnuson-Stevens Fishery

Conservation and Management Act (MSA). The GMFMC works together with NOAA Fisheries to manage commercially and recreationally important marine fish stocks and to prepare Fishery Management Plans (FMPs) for target species. Threats to the sustainability of marine fisheries result from both fishing and non-fishing activities. Notable impacts of fishing include habitat destruction by gear (for example, trawls, nets, traps) and bottom anchors; overharvest; bycatch; and "ghost" fishing by discarded or derelict gear (Pauly 2007). Non-fishing activities known to impact fisheries in specific areas include coastal development; contaminants; dredging; maritime traffic; water intake structures; oil and gas development; pipeline installation; marine mining; and others. Climate change, sea level rise, and invasive species are recognized as widespread threats to fisheries (Karnauskas et al. 2015; Hallowed et al. 2013; Doney et al. 2012; Mendelssohn et al. 2012; Zimmerman and Minello 2010).

The GMFMC manages fisheries within the Federal waters surrounding the proposed Port site. Marine recreational and commercial fishing in Louisiana State waters (Louisiana Act 336 extended jurisdictional waters to those within 9 nautical miles [10.4 statute miles]; however, the U.S. Congress has yet to confirm this action and waters within the 3 nautical mile [3.5 statute mile] and 9 nautical mile lines remain under Federal jurisdiction by Federal agencies) are the responsibility of the Louisiana Department of Wildlife and Fisheries (LDWF). Until such time as the U.S. Congress has approved the actions taken by Louisiana Act 336, Federal agents and the USCG will continue to enforce Federal law and the LDWF will concurrently enforce Louisiana State regulations out to the 9 nautical mile line.

Species in the proposed Project area are managed under the following FMPs:

- Shrimp Fishery of the Gulf of Mexico, U.S. Waters;
- Red Drum Fishery of the Gulf of Mexico;
- Reef Fish of the Gulf of Mexico;
- Coastal Migratory Pelagic Resources in the Gulf of Mexico;
- Spiny Lobster in the Gulf of Mexico and South Atlantic; and
- Coral and Coral Reefs of the Gulf of Mexico.

In addition, NOAA Fisheries has developed Secretarial FMPs for highly migratory species (HMS), including billfish, tuna, swordfish, and sharks that range across more than one FMP. Managed species are discussed in greater detail in Section 3.4 and Appendix E.

3.3.12.2 Commercial Fisheries

Commercial fisheries landings are tracked by NOAA Fisheries, Fisheries Statistics Division and made available to the public online[19] and in an annual summary, *Fisheries of the United States* (NOAA Fisheries 2015r). The text below represents the most recent data available for the Gulf of Mexico from these two sources. The Gulf of Mexico provides almost 17 percent of the commercial fish landings in the continental United States (NOAA 2014a). Total commercial landings from the Gulf of Mexico between 2004 and 2013 were nearly 1 billion pounds per year, with most attributed to Louisiana landings (Table 3.3-5). The notable spike in landings in 2011 may be attributed to rebound following fisheries closures associated with the Deepwater Horizon oil spill in spill in 2010.

In 2014, Louisiana had the second highest commercial fisheries landings in the United States at 872.2 million pounds (NOAA Fisheries 2016a). Louisiana consistently had the highest landings in the Gulf of Mexico region from 2004 through 2014 (NOAA Fisheries 2016a), with the ports of Empire-Venice and Dulac-Chauvin listed in the top 15 ports of the United States for both landings and value in 2014 (NOAA Fisheries 2016a); however, these ports are located at least 200 miles from the proposed Port location. Shrimp is the most important fisheries commodity in terms of dollars and menhaden is the most important

[19] See http://www.st.nmfs.noaa.gov/commercial-fisheries/commercial-landings/annual-landings/index

fishing commodity in terms of pounds, at about 0.48 billion pounds per year; other important species are crab, oysters, and mullet. Annual landings of Louisiana brown shrimp over this time averaged 3.7 million pounds (NOAA Fisheries 2015r).

Table 3.3-5. Commercial Fisheries Landings and Values for the Gulf of Mexico and Louisiana (2004 to 2013)

Year	Gulf-wide		Louisiana	
	Pounds	Value ($)	Pounds	Value ($)
2004	1,475,139,115	669,001,753	1,095,571,136	274,081,780
2005	1,198,202,920	625,038,379	849,280,372	251,678,265
2006	1,362,325,597	691,220,009	918,674,923	278,291,550
2007	1,404,016,021	690,153,114	999,051,803	289,230,436
2008	1,278,879,162	663,847,717	919,016,927	275,700,601
2009	1,435,665,309	636,427,434	1,007,474,064	286,992,923
2010	1,072,068,111	624,628,617	793,376,931	233,558,563
2011	1,792,550,312	811,904,803	1,311,040,048	324,122,880
2012	1,293,195,996	753,981,039	849,408,283	301,847,473
2013	1,392,365,074	936,660,783	1,041,189,852	399,515,845
2014	1,238,223,659	1,048,612,945	872,249,397	487,068,169
Total	**14,942,631,276**	**8,151,476,593**	**10,656,333,736**	**3,402,088,485**
Source: All years except 2014: NOAA Fisheries 2015r; 2014 data: NOAA Fisheries 2016a				

3.3.12.3 Recreational Fisheries

Sport fishing is an important activity in Gulf of Mexico waters and inland waterways. In the Gulf of Mexico, 7 percent of recreational fishing is conducted from charter boats and about 50 percent is done from private or rented boats. The remaining 43 percent of recreational fishing occurs onshore. As shown in Table 3.3-6, marine fishing is a prominent recreational activity in both Louisiana and Texas that brings a considerable number of tourists to the coast every year.

Spotted seatrout (*Cynoscion nebulosus*), Spanish mackerel, and Atlantic croaker (*Micropogonias undulatus*) are the most commonly caught non-bait species (by numbers of fish). By weight, the largest harvests are typically red drum (*Sciaenops ocellatus*), spotted seatrout, sheepshead (*Archosargus probatocephalus*), red snapper, Spanish mackerel, king mackerel (*Scomberomorus cavalla*), and dolphin (O'Bannon 2002).

Table 3.3-6. Recreational Fishing Effort, Landings, and Releases in Louisiana and Texas from the Gulf of Mexico (2004 to 2013)

Year	State	Angler Trips	Total Landings a/ (lbs)	Total Released a/ (lbs)
2004	Louisiana	2,250,691	15,848,474	22,961,884
	Texas	1,126,558	2,014,548	NA
2005	Louisiana	4,065,078	13,014,471	19,293,367
	Texas	1,061,479	1,847,949	NA
2006	Louisiana	3,763,274	16,273,961	21,488,328
	Texas	1,156,790	2,115,635	NA
2007	Louisiana	4,188,282	14,937,398	1,917,1321
	Texas	1,057,814	1,821,398	NA

Table 3.3-6. Recreational Fishing Effort, Landings, and Releases in Louisiana and Texas from the Gulf of Mexico (2004 to 2013) (continued)

Year	State	Angler Trips	Total Landings a/ (lbs)	Total Released a/ (lbs)
2008	Louisiana	4,620,056	18,234,349	22,770,494
	Texas	1,055,600	1,838,743	NA
2009	Louisiana	4,128,014	16,642,340	20,161,303
	Texas	1,041,027	1,806,913	NA
2010	Louisiana	3,862,487	13,776,038	18,370,898
	Texas	991,485	1,733,761	NA
2011	Louisiana	4,576,247	17,714,013	20,246,288
	Texas	1,125,401	2,483,184	NA
2012	Louisiana	4,136,564	15,293,294	20,033,417
	Texas	1,159,189	2,257,311	NA
2013	Louisiana	4,661,154	16,253,583	26,749,766
	Texas	1,149,597	2,009,146	NA
2014	Louisiana	2,188,000	6,150,216	NA
	Texas	1,069,000	1,628,564	NA

Note:
a/ All species combined.
Key: NA = Not Available
Source: Landings data, all years except 2014: NOAA Fisheries (2015s);
2014: https://www.st.nmfs.noaa.gov/SASStoredProcess/do?

3.4 Essential Fish Habitat

Commercial and recreational fisheries resources in the Federal waters of the Gulf of Mexico are managed by the GMFMC and NOAA Fisheries under the auspices of the MSA, as described in Section 3.3.12. The MSA was implemented to address widespread threats of habitat degradation and loss on managed fisheries (GMFMC 2005).

The GMFMC and NOAA Fisheries have identified waters and substrate necessary to fish for spawning, breeding, feeding, and growing to maturity as EFH. Habitat areas of particular concern (HAPC) are designated specifically for fishing activities and include localized areas of EFH that are ecologically important, sensitive, stressed, and/or a rare area. For example, portions of the Flower Garden Banks are designated HAPCs for corals (BOEM 2012a) and a large deep open water area is considered HAPC for Atlantic bluefin tuna (*Thunnus thynnus*) (Figure 3.4-1).

The GMFMC FMPs provide details on EFH and other management issues for commercially, recreationally, and ecologically important resources, including corals and coral reefs, shrimp, spiny lobster, reef fishes, coastal migratory pelagic fishes, and red drum. Virtually the entire northern coast of the Gulf of Mexico to a depth of about 600 ft (183 m) has been identified as EFH for at least one species. EFH for corals and coral reefs includes shallow topographic features in the Central and Western Planning Areas.

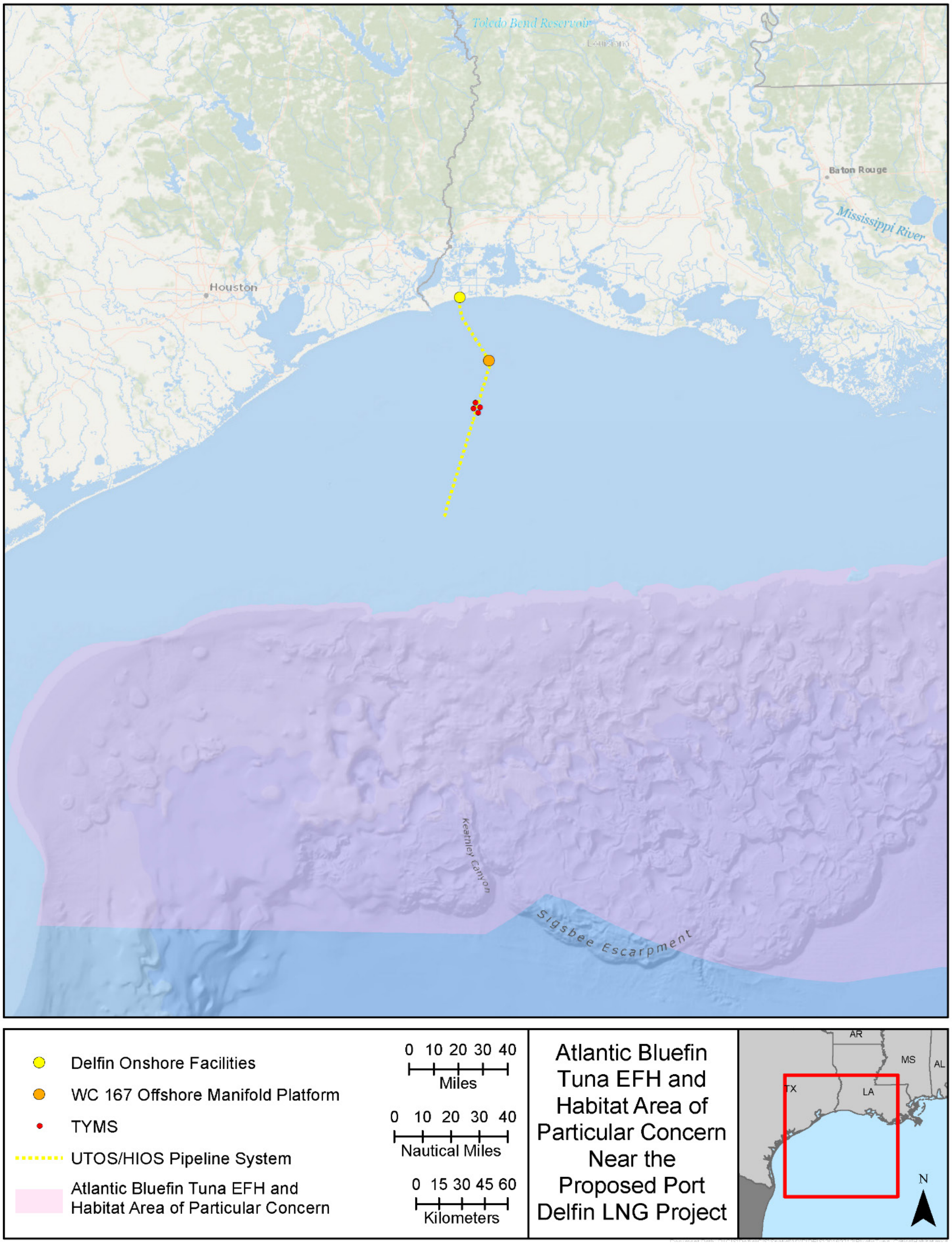


Figure 3.4-1. Atlantic Bluefin Tuna EFH and Habitat Area of Particular Concern Near the Proposed Port Delfin LNG Project

3.4.1 Definition of the Resource

EFH, as defined in the 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act, includes waters necessary to fish through all life stages, including spawning, breeding, feeding, or growth to maturity. Nearly 1,000 species have an EFH description; however, for this document, EFH is limited to the various managed species with EFH in the proposed Project area, including coastal migratory pelagics, reef fish, shrimp, and highly migratory species.

3.4.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to EFH (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- Sustainable Fisheries Act amendments to the Magnuson-Stevens Fishery Conservation and Management Act

3.4.3 Required Permits

There are no specific permits required for the proposed Project with regards to EFH; however, the Magnuson-Stevens Fishery Conservation and Management Act provides that Federal agencies must consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect EFH.

3.4.4 Existing Threats

FMPs prepared in accordance with 50 CFR part 600 (Subpart J) include an evaluation of non-fishing impacts on EFH. Under this directive, NOAA Fisheries and the Fishery Management Councils have evaluated effects of non-fishing activities on the quality and quantity of EFH in various regions of the country, including the Gulf of Mexico (GMFMC 2010). The reports are in general agreement that primary threats to EFH include the following: dredging, filling, mining, impounding waters, diverting waters, thermal discharges, non-point source pollution and sedimentation, introduction of hazardous materials or exotic species, and modifying/converting aquatic habitat. Events occurring over a larger spatial scale, such as severe weather and climate change, often exacerbate the local effects to EFH caused by specific human activities.

3.4.5 Categories of EFH by Life Stage of Managed Species

EFH is designated based on two components: the life stage of the species and the habitat type required during that life stage. Life stages and habitats are described separately below.

The GMFMC identifies categories of EFH based on the needs of the managed species during each life stage: eggs, larvae, post-larvae, early juveniles, late juveniles, adults, and spawning adults. Eggs are the fertilized product of individuals that have spawned; they depend completely on their yolk-sac for nutrition in this unhatched phase. Larvae are individuals that have hatched and can capture prey. Juveniles are individuals that are not sexually mature but that have fully formed organ systems, similar to those of adults. Adults are sexually mature individuals that are not necessarily in spawning condition, and spawning adults are those individuals capable of producing offspring.

Life stages of highly migratory species are grouped in three categories based on common habitat usage: (1) spawning adult, egg, and larva; (2) juvenile and subadult or juvenile; and (3) adult. Subadults are individuals just reaching sexual maturity. The juvenile and subadult category combines all life stages between age 1 year and maturity. Adults are sexually mature fish. Young-of-the-year are individuals born within the past year. Additionally, EFH life stage categories for sharks are defined as neonate (primarily includes newborns and only small young-of-the-year), juvenile (includes all immature sharks from young to older and late juveniles), and adult (sexually mature sharks—largest size class).

The GMFMC and NOAA Fisheries have subdivided the Gulf of Mexico into five Eco-Regions, each with three coastal zone designations. The proposed project is in Eco-Region 4, which ranges from the Mississippi River Delta to Freeport, Texas. Eco-Region 4 is directly influenced by the Mississippi and Atchafalaya Rivers and contains extensive areas of marsh. Rocky reefs are found offshore this eco-region (NOAA Fisheries 2015t).

The proposed Project is expected to overlap with 2 of the 12 habitat types identified as EFH in the Gulf of Mexico (NOAA Fisheries 2015t):

- soft bottom and pelagic,
- mangroves,
- emergent marsh (tidal wetlands, salt marshes, tidal creeks),
- drift algae,
- oyster reefs,
- submerged aquatic vegetation (SAV; seagrasses, benthic algae),
- reefs (reef halos, patch reefs, deep reefs),
- hard bottom (live bottom, low- relief bottoms, and high-relief bottoms),
- soft bottom (mud, clay, silt),
- sand/shell bottom (sand, shell),
- banks/shoals,
- shelf edge/slope (shelf edge, shelf slope), and
- pelagic.

Pelagic EFH is the water column itself, apart from associated benthic or structural features, provides EFH for many species. Neritic and coastal waters occur above the continental shelf and roughly encompass the top 600 ft (200 m) of the ocean known as the photic zone, where sunlight can penetrate and photosynthesis can occur. All waters from the surface to the ocean floor (but not including the ocean bottom) are part of the marine water column. The water column is particularly important for planktonic life stages (eggs and larvae) and all life stages of planktivorous species (NMFS 2000, 2009). The Loop Current in the Gulf of Mexico provides critical transport of larvae and floating *Sargassum*, connecting populations in the Gulf of Mexico, the Caribbean Sea, and the Atlantic Ocean (BOEM 2012a).

Soft-bottom benthic habitat refers to any seafloor habitats, except for hard bottom, as well as the water-sediment interface used by many invertebrates (for example, members of the shrimp management unit). Soft-bottom unconsolidated bottom habitats include loose rocks, gravel, cobble, pebbles, sand, clay, mud, silt, and shell fragments. A variety of species use these unconsolidated bottom habitats for spawning and nesting, development, dispersal, and feeding (NMFS 2000).

Soft-bottom sediments range in size from gravel (larger than 2.0 mm) to sand (0.05 to 2.0 mm), silt (0.002 to 0.05 mm), and clay (< 0.002 mm). Sediment deposited on the continental shelf is mostly delivered by rivers, but also by local and regional currents and wind (Wren and Leonard 2005). Sediment quality is influenced by its physical, chemical, and biological components; where it is deposited; the properties of seawater; contaminants; and other factors. Because all these factors interact to some degree, sediments tend to be dynamic and are not easily generalized. Benthic fauna and infauna often rework sediments in the process of feeding and burrowing. In this way, marine organisms can influence the structure, texture, and composition of sediments as well as the horizontal and vertical distribution of substances in the sediment (Boudreau 1998).

3.4.5.1 Managed Species with EFH in Project Area

EFH has been designated for several groups of managed fishes in the Gulf of Mexico that occur within the ROI, including coastal migratory pelagics, reef fish, shrimp, and HMS (Table 3.4-1). No EFH for red drum (*Scianops ocellatus*) or spiny lobster (*Panulirus argus*) is designated within the ROI (NOAA Fisheries SERO 2016).

Table 3.4-1. Fisheries with Essential Fish Habitat in the Proposed Project Area

Common Name	Species Name
Coastal Migratory Pelagics Fishery Management Plan	
In the Management Unit	
King mackerel	*Scomberomorus cavalla*
Spanish mackerel	*Scomberomorus maculatus*
Cobia	*Rachycentron canadum*
In Fishery but not in the Management Unit	
Cero	*Scomberomorus regalis*
Little tunny	*Euthynnus alletteratus*
Dolphin	*Coryphaena hippurus*
Bluefish (Gulf of Mexico only)	*Pomatomus saltatrix*
Reef Fish Fishery Management Plan	
Snappers Lutjanidae family	
Queen snapper	*Etelis oculatus*
Mutton snapper	*Lutjanus analis*
Blackfin snapper	*Lutjanus buccanella*
Red snapper	*Lutjanus campechanus*
Cubera snapper	*Lutjanus cyanopterus*
Gray (mangrove) snapper	*Lutjanus griseus*
Lane snapper	*Lutjanus synagris*
Silk snapper	*Lutjanus vivanus*
Yellowtail snapper	*Ocyurus chrysurus*
Wenchman	*Pristipomoides aquilonaris*
Vermilion snapper	*Rhomboplites aurorubens*
Groupers Serranidae family	
Speckled hind	*Epinephelus drummondhayi*
Yellowedge grouper	*Epinephelus flavolimbatus*
Goliath grouper	*Epinephelus itajara*
Red grouper	*Epinephelus morio*
Warsaw grouper	*Epinephelus nigritus*
Snowy grouper	*Epinephelus niveatus*
Black grouper	*Mycteroperca bonaci*
Yellowmouth grouper	*Mycteroperca interstitialis*
Gag	*Mycteroperca microlepis*
Scamp	*Mycteroperca phenax*
Yellowfin grouper	*Mycteroperca venenosa*

Table 3.4-1. Fisheries with Essential Fish Habitat in the Proposed Project Area (continued)

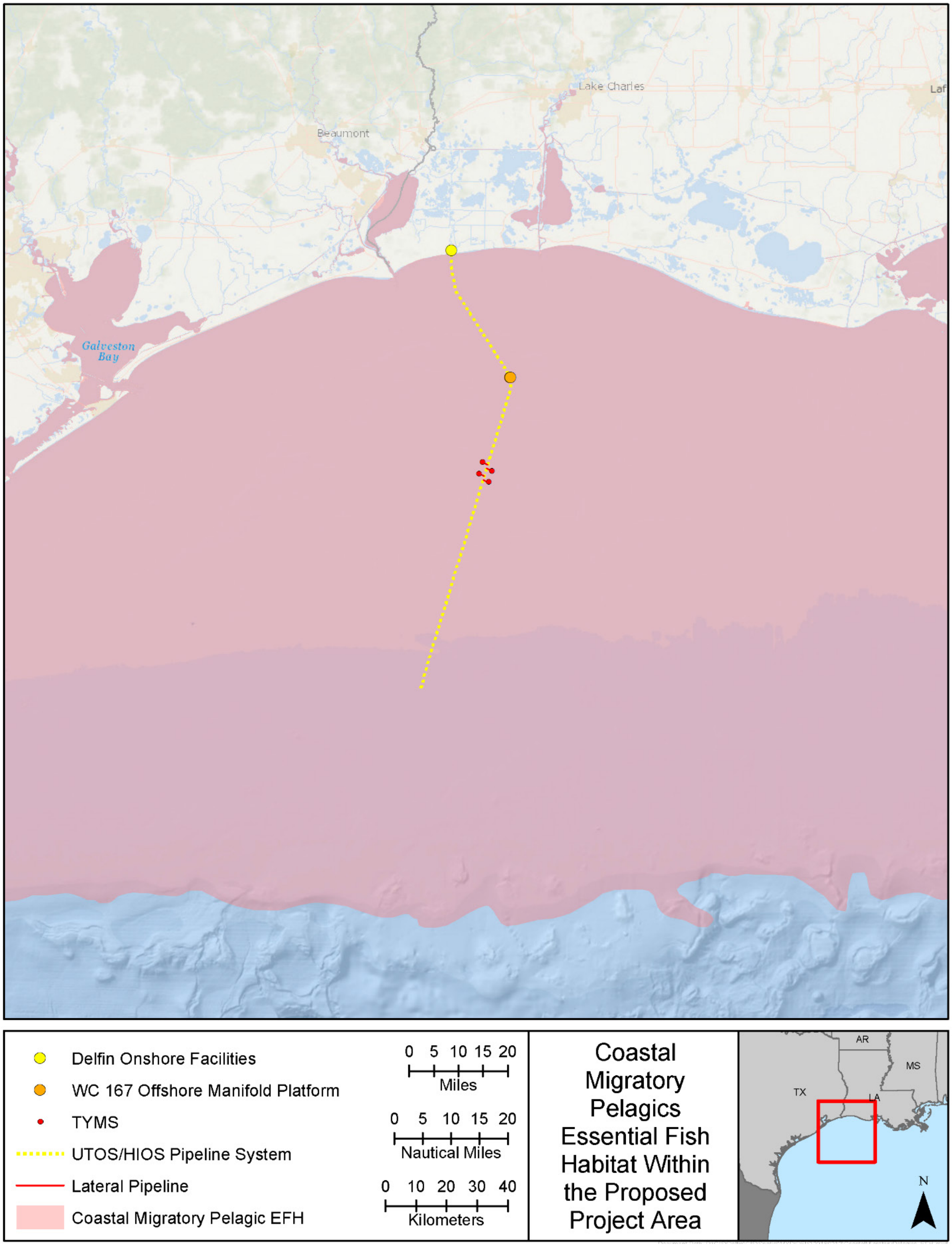
Common Name	Species Name
Tilefishes Malacanthidae family	
Goldface tilefish Blueline tilefish Tilefish	*Caulolatilus chrysops* *Caulolatilus microps* *Lopholatilus chamaeleonticeps*
Jacks Carangidae family	
Greater amberjack Lesser amberjack Almaco jack Banded rudderfish	*Seriola dumerili* *Seriola fasciata* *Seriola rivoliana* *Seriola zonata*
Triggerfishes Balistidae family	
Gray triggerfish	*Balistes capriscus*
Wrasses Labridae family	
Hogfish	*Lachnolaimus maximus*
Shrimp Fishery Management Plan	
Brown shrimp White shrimp Pink shrimp Royal red shrimp	*Farfantepenaeus aztecus* *Litopenaeus setiferus* *Farfantepenaeus duorarum* *Pleoticus robustus*

3.4.5.2 Coastal Migratory Pelagics

King mackerel, Spanish mackerel, and cobia are managed within the group of coastal migratory pelagics, species that typically migrate throughout the Gulf and South Atlantic. Adults of these commercially and recreationally valuable species occur in nearshore waters, but eggs hatch and larvae are reared in open waters farther offshore (Table 3.4-2). Designated EFH for coastal migratory pelagic species ranges across the northern Gulf of Mexico from the shoreline out to the continental shelf (Figure 3.4-2).

Table 3.4-2. Coastal Migratory Pelagics EFH

Species	Eggs	Larvae	Juveniles	Adults
King mackerel	Pelagic and occur offshore in spring and summer	Mid to outer continental shelf (25-180 m; 82-590 ft) in October and feed on other larval fishes	Inshore waters on the inner shelf and feed on estuarine dependent fish	Pelagic and occur in coastal to offshore waters, feed on nekton, and spawn from May to October on the outer continental shelf
Spanish mackerel	Pelagic and found on the continental inner shelf (<50 m; 164 ft) in spring and summer	Continental inner shelf from spring to fall and feed on larval fishes	Estuarine and coastal waters with a wide salinity range and feed on fishes	Inshore and coastal waters, feed on estuarine dependent fishes, and spawn on the inner shelf from May to September
Cobia	Top meter of the water column	Offshore waters	Coastal waters and offshore on the shelf in the upper water column, found in the summer, and feed on nekton	Shallow coastal waters and offshore shelf waters (1-70 m; 3-229 ft) from March to October and spawn in the shelf waters in the spring and summer
Source: BOEM (2012a) Volume 3				



Source: NOAA Fisheries (2015u)

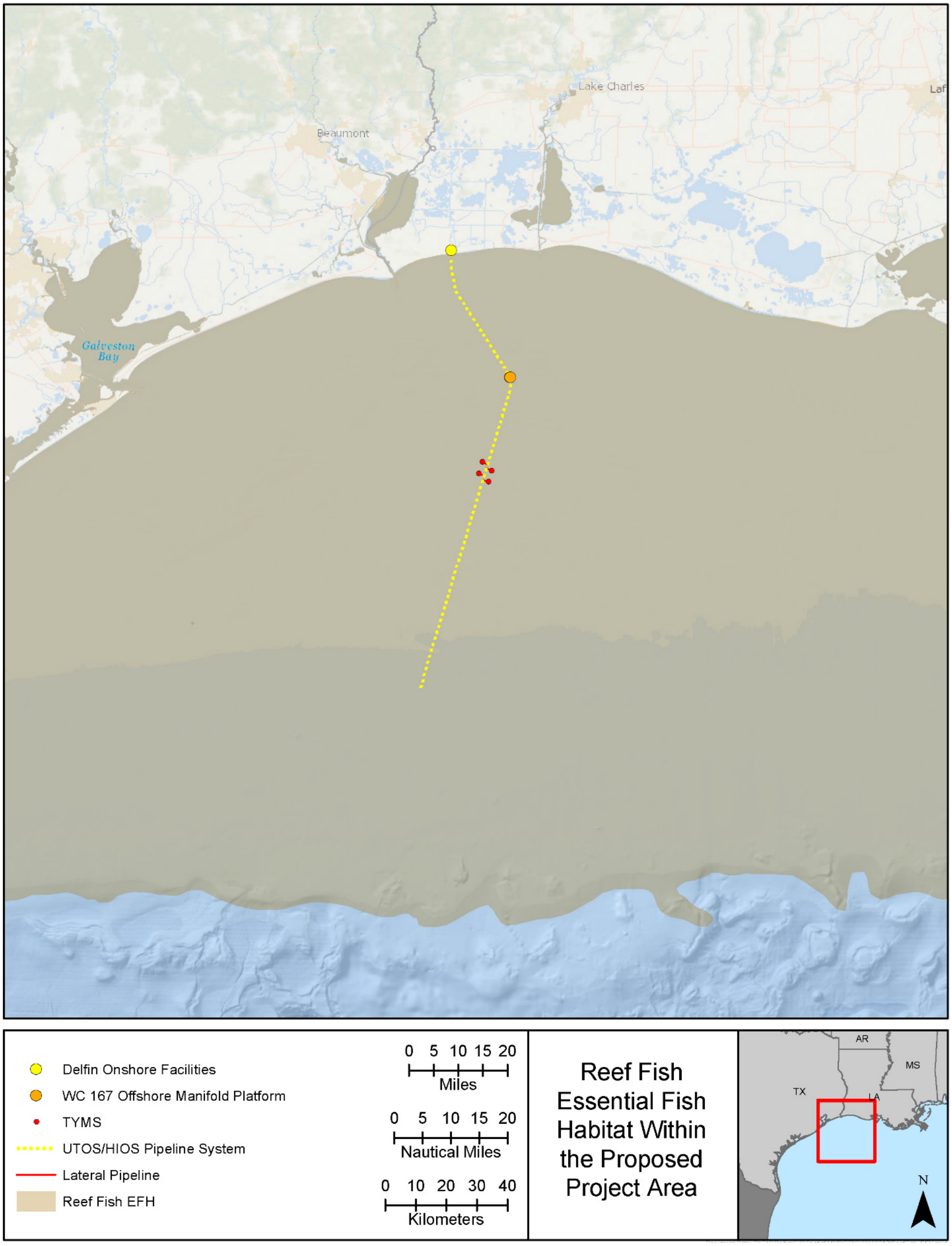
Figure 3.4-2. Coastal Migratory Pelagics Essential Fish Habitat within the Proposed Project Area

3.4.5.3 Reef Fish

The reef fish FMP includes fishes associated with natural and artificial reefs and other hard-bottom habitats, such as snappers, groupers, amberjack, bass, triggerfish, hogfish, porgies, and tilefish. Most of these species are recreationally and commercial valuable. Despite the common association with hard-bottom habitat, species managed as reef fish have diverse life history characteristics; note the use of artificial structures by various life stages of the selected examples in Table 3.4-3. Designated EFH for reef fish ranges across the entire nearshore zone in the northern Gulf of Mexico (Figure 3.4-3).

Table 3.4-3. EFH for Various Life States of Selected Reef Fishes

Species Name	Eggs	Larvae	Post Larvae	Juveniles	Adults
Grey trigger	Sand bottoms near reef habitats in the spring and summer seasons	None	Upper water column in spring and summer seasons	Upper water column associated with *Sargassum* and eat from *Sargassum*	Continental shelf waters (>10 m; 33 ft), reefs in the late spring and summer, and eat invertebrates
Greater amberjack	Gulfwide	Gulfwide	Offshore in the summer	Gulfwide with floating structures (*Sargassum*) in the late summer and fall and feed on invertebrates	Gulfwide near the structured habitat, eat invertebrates and fishes, and spawn in the spring and summer offshore
Red snapper	Offshore in the summer and fall	Continental shelf waters in summer and fall, and eat rotifers and algae	None	Continental shelf associated with structures and feed on zooplankton and shrimp	Hard and irregular bottoms, eat nekton, and spawn offshore away from coral reefs in sand bottoms with low relief in summer and fall
Gray snapper	High salinity continental shelf waters near coral reefs in the summer	High salinity continental shelf waters near coral reefs in the summer and eat zooplankton	Move to estuaries with vegetation (seagrass), wide salinity and temperature ranges, and eat copepods and amphipods	Feed on crustaceans	Onshore and offshore, eat nekton, and spawn offshore near reefs in summer
Yellowtail snapper	Found in February and October	Shallow water with vegetation and structure and feed on zooplankton	None	Nearshore with vegetation and move to shallow coral reefs with age	Semipelagic and use deeper coral reefs (50 m; 164 ft), feed on nekton, and spawn away from shore with peaks in February-April and September-October
Source: BOEM (2012a) Volume 3					



Source: NOAA Fisheries (2015u)

Figure 3.4-3. Reef Fish Essential Fish Habitat within the Proposed Project Area

3.4.5.4 Shrimp

Adult brown and white shrimp are most common in the proposed Project's ROI, where the soft-bottom substrate is designated as EFH (Table 3.4-4 and Figure 3.4-4).

Table 3.4-4. EFH for Brown and White Shrimp

Species	Eggs	Larvae	Post larvae	Juveniles	Adult
Brown shrimp	None	None	Migrate to estuaries in early spring	Associated with vegetation and mud bottoms, and sub-adults utilize bays and shelf as they move from estuaries to offshore waters	Spawn in deep waters (>18 m; 59 ft) over the continental shelf generally in the spring
White shrimp	Spring and fall	None	None	Associated with soft bottoms with detritus and vegetation	Nearshore soft bottoms and spawn at <27 m (88 ft) from spring to fall, and migrate through the water column between night and day

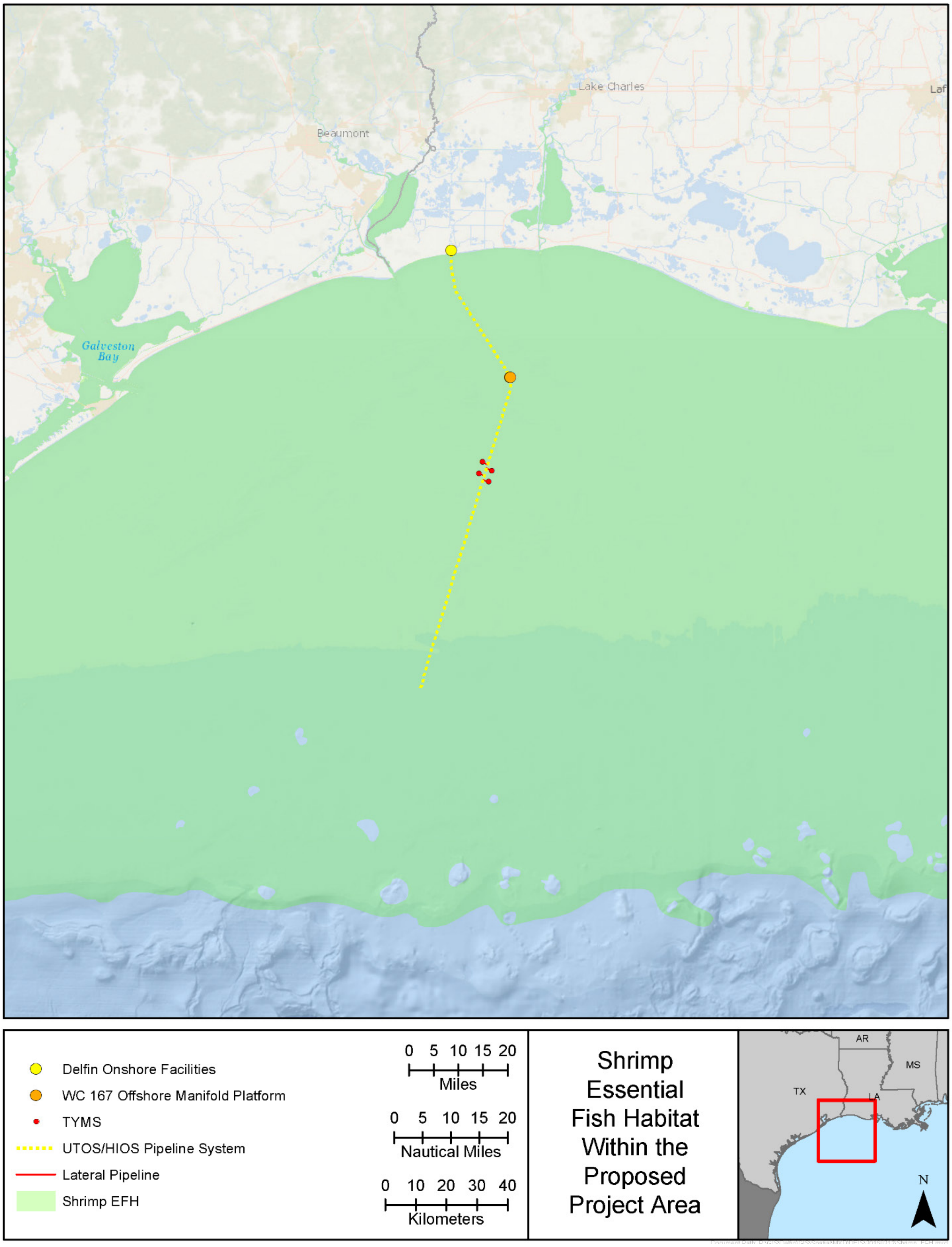
3.4.5.5 Highly Migratory Species

Of the many HMS with EFH in the Gulf of Mexico, the Atlantic bluefin tuna, bonnethead shark (*Sphyrna tiburo*), and Atlantic sharpnose shark (*Rhizoprionodon terraenovae*) are most likely to overlap with the proposed Project area. Once the proposed Port is constructed, it may attract HMS species, many of which are known to aggregate around artificial structures in open water.

3.4.5.6 Eggs and Larvae within the Proposed Project Area

Ichthyoplankton (fish and invertebrate eggs and larvae) make up a substantial portion of the zooplankton community, as most fishes in the Gulf of Mexico have pelagic larval stages (BOEM 2012a). Distribution and abundance of ichthyoplankton is a function of adult movement, spawning season, currents, and other physical and biological parameters that vary spatially and temporally. Seasonal patterns of ichthyoplankton composition in nearshore waters are strongly influenced by the spawning cycles of coastal fish species, while further offshore composition is influenced by the spawning cycles of pelagic and migratory species. The Mississippi River discharge plume and the Loop Current have widespread influence over patterns of ichthyoplankton abundance throughout the Gulf of Mexico.

Several managed species are expected to spawn within or near the proposed Project area. For most Gulf of Mexico species, the larval stage last between 10 and 100 days, depending on the species. The distribution of fish larvae depends on spawning behavior of adults, hydrographic structure and transport at a variety of scales, duration of the pelagic period, behavior of larvae, and larval mortality and growth (BOEM 2012a). For most of the year in the north-central Gulf of Mexico, density of ichthyoplankton is greater at the surface and decreases with depth (Shaw et al. 2002). Some larvae undergo daily vertical migrations in response to daylight (Shaw et al. 2002). Larval fishes are highly dependent on zooplankton until they can feed on larger prey. The composition of larval fish assemblages varies with season, mediated by temperature, day length, nutrient supply, and other factors (BOEM 2012a). In general, larval densities are lowest during winter, increase during the spring, peak during the summer, and decline during the fall, as shown in Table 3.4-5. Many of the managed fish and invertebrates are in the ROI in the spring, late spring, and early fall. From May through October, king and Spanish mackerel and many of the snappers are present.



Source: NOAA Fisheries (2015u)

Figure 3.4-4. Shrimp Essential Fish Habitat within the Proposed Project Area

Table 3.4-5. Peak Seasonal Occurrence of Larval Fishes for Select Managed Species in the Northern Gulf of Mexico

Family (Common Name)	Taxa (Common Name)	Scientific Name	Month											
			J	F	M	A	M	J	J	A	S	O	N	D
Sea Bass	Groupers	*Epinephelus* spp.	X	X			X	X	X	X	X	X	X	
		Myctoperca spp.				X								
		Serranus spp.	X	X		X	X	X	X	X	X	X	X	X
Cobia	Cobia	*Rachycentron canadum*				X	X	X	X	X	X			
Jacks	Amberjacks	*Seriola* spp.	X	X	X	X	X	X	X	X	X	X	X	X
Triggerfish	Triggerfish	*Balistes* sp.							X	X				
Snapper	Wenchman	*Pristipomoides aquilonaris*		X			X	X	X	X	X	X		
	Vermillion snapper	*Rhomboplites aurorubens*	X				X	X	X	X	X	X	X	
	Queen snapper	*Etelis oculatus*							X	X	X	X	X	
	Red snapper	*Lutjanus campechanus*				X	X	*	*	*	X	X	X	
	Gray snapper	*Lutjanus griseus*				X	X	*	*	*	X	X	X	
	Lane	*Lutjanus synagris*				X	X	*	*	*	X	X	X	
Mackerels, Tunas, Wahoo	Little tunny	*Euthynnus alletteratus*				X	*	*	*	*	*	X	X	
	King mackerel	*Scomberomorus cavalla*					X	X	X	*	*	X	X	
	Spanish mackerel	*Scomberomorus maculatus*				X	X	X	X	*	*	X		
	Bluefin tuna	*Thunnus thynnus*				X	X	X						

Key:
X = Seasonality
* = Peak Seasonal Occurrence.
Source: Ditty et al. (1988)

Ichthyoplankton resources were surveyed by NOAA Fisheries as part of SEAMAP. Plankton were collected using neuston nets and bongo nets. Ichthyoplankton abundance in the proposed Project area was estimated using samples from a 30- by 30-nautical mile (34.5- by 34.5-statute mile; 55.5- by 55.5-km) coverage of SEAMAP sampling stations near the proposed Port location (Figure 3.4-5). Bongo net data between 1983 and 2012 for the 59 SEAMAP stations within the established block had an overall density of 0.274 fish larvae/m^3 and 4.616 eggs/m^3. Those densities are represented as an average of 1,037 larvae and 17,484 eggs per million gallons of seawater. As noted above, the distribution and abundance of ichthyoplankton is highly variable on temporal and spatial scales. None of the 20 most abundant taxa identified in samples from the proposed Project area are managed species.

Data from samples collected during this Gulf-wide survey were used to identify ichthyoplankton expected to occur within the ROI of the offshore facilities. More than 1,200 taxonomic categories, including unidentified specimens, were identified in plankton samples collected in the proposed project area (see Appendix E and Appendix H). Samples were collected from June through November over 29 years (1983 to 2012).

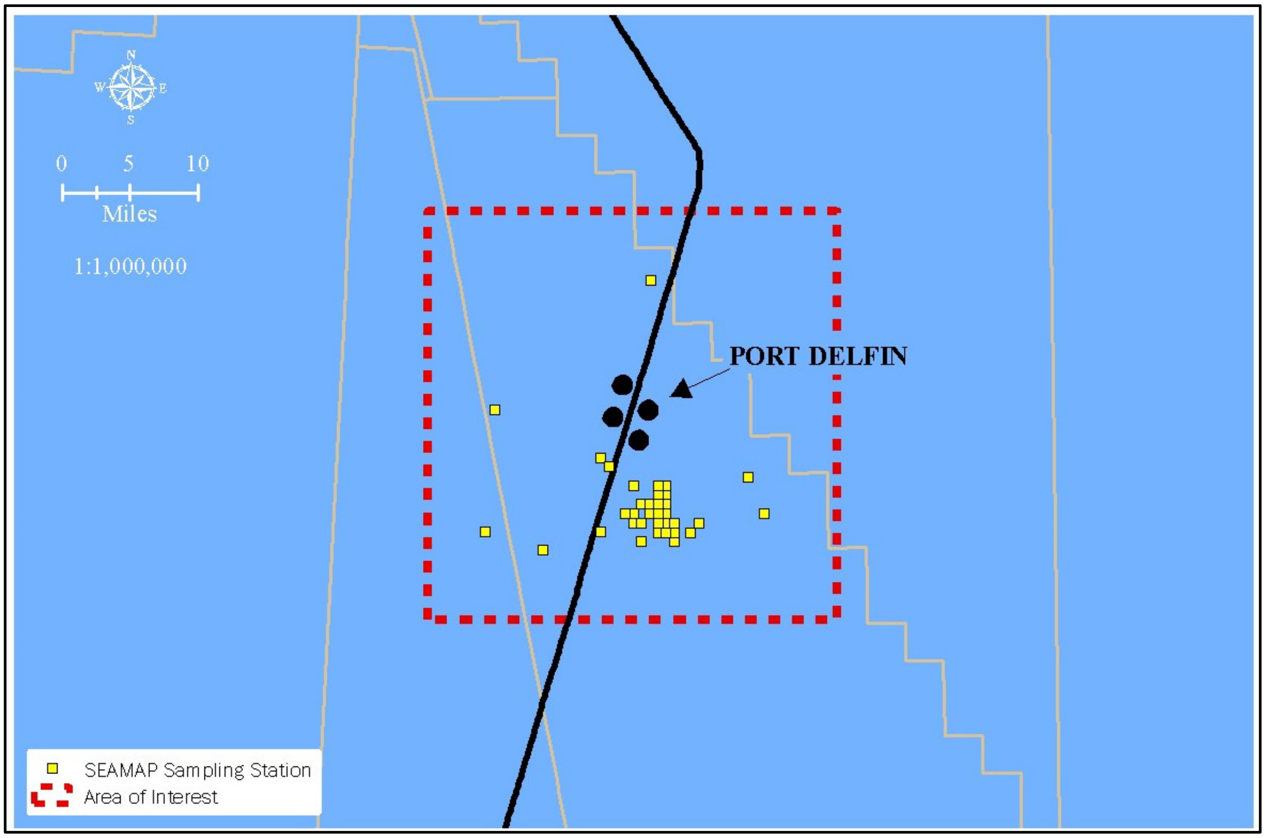


Figure 3.4-5. SEAMAP Stations within the Proposed Project's Area of Interest

3.5 Offshore Geologic Resources

This section is limited to discussion of offshore geological resources; geological resources located onshore are addressed in Section 3.13.

3.5.1 Definition of the Resource

This section describes the geologic resources within and surrounding the proposed Port. Geologic resources consist of the surface and near-surface materials (i.e., rock and soil) of the earth and the regional or local forces by which they are formed. These resources are typically described in terms of bathymetry, regional and local geology, soil resources, topography, mineral (paleontological, if applicable) resources, and geologic hazards. Bathymetry involves the geomorphic characteristics of the seafloor surface, including elevations, relationship with adjacent land features, and geographic location. Regional and local geologic resources comprise earth materials within a specified region and the forces that have shaped them, including bedrock or sediment type and structure, unique geologic features, the depositional or erosional environment, and age or history. Soil resources are the unconsolidated terrestrial material and are discussed in Section 3.13.5 along with onshore conditions.

Mineral and paleontological resources include potentially accessible geologic materials with economic or academic value and significant artifacts. Geologic hazards comprise the regional or local forces or conditions that could affect a proposed development or use (e.g., seismicity, liquefaction, slope stability, competency of bedrock, and subsidence or settlement).

3.5.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to offshore geological resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- USEPA CWA, Sections 401 and 404

3.5.3 Required Permits

- USEPA CWA Section 401 Water Quality Certification

3.5.4 Existing Threats

The likelihood of seismic activity and seafloor subsidence in the Project area is very low. Installation of structures on the seafloor is a threat, but impacts from this type of activity would most likely be minimal as long as proper surveying is conducted beforehand.

3.5.5 Existing Conditions

The coastal region of the southern United States is part of the Gulf of Mexico basin. This region is currently considered a tectonically passive continental margin dominated by sedimentary processes. The existing geological conditions for the proposed Project are discussed in the following subsections.

3.5.5.1 Regional Geology

During the late Jurassic Period tectonic activity due to the opening of the Gulf of Mexico resulted in the formation of numerous rift basins. Continued tectonic activity periodically flooded these basins with salt water. This period of sea-water inundation and evaporation resulted in thick accumulations of salt deposits. As tectonic activity waned these salt deposits were overlain by thick layers of sand and mud from the erosion of the continent. This continued sedimentation migrated the continental shelf seaward away from the continental margin or shoreline. This process resulted in a south-dipping monocline with an average regional dip is about 150 ft per mile at depths of 10,000 to 12,000 ft below land surface. This regional dip is interrupted by anticlinal uplifts (many of which are underlain by salt diapirs) and by normal faults that dip predominately to the south. Structurally, the combination of salt tectonics and sediment loading contributed to shallow-dipping, down-to-the south, normal listric faulting (Galloway et al. 1991).

This series of pre-quaternary sediments is referred to as the Fleming Formation (Louisiana Geological Survey 2000). The Fleming Formation has several distinct members but overall consists of a thick sequence of alternating beds of silty clays and sands, which can be of marine, brackish, or fresh water deposition. In addition, some of the units can be calcareous and tuffaceaous. These sequences would be typical of the sedimentary environment they have been proposed to have evolved in and can change over short distances both vertically and horizontally.

Quaternary Period sedimentary deposits that originated from rivers and deltas overlie this formation and underlie the State of Louisiana and the adjacent Northern Gulf of Mexico Shelf. The presence of these deposits indicate that a major river system corresponding to the Mississippi River has persisted in the Louisiana region at least since the beginning of the formation of the Gulf of Mexico.

Near surface deposition in the study area has been largely influenced by a series of depositional events associated with eustatic sea level changes from climatic variation during the Pleistocene. Estimates of sea level lowering are on the order of 300 to 500 ft below present. This results in periods of exposure of sea floor to the atmosphere with the resulting impacts from wind, rain and sun.

3.5.5.2 Local Geology and Sediment Characteristics

The geology and sediments of the proposed Port area were evaluated by geophysical techniques and sediment cores. Sediment cores were taken near each of the proposed mooring locations. The sediments range from very soft to firm gray clay, silty clay, and sandy clay. Several minor inclusions such as pockets or seams of contrasting material as well as shell fragments were observed. In Core L2 FLNG 2, a few small pieces of gravel were present. Miniature vane shear strengths (undisturbed) ranged from 21 to 902 pounds per square foot. The firm clay in Core L2 FLNG 1 (721 pounds per square foot shear strength) and firm silty clay present in Core L2 FLNG 4 (902 pounds per square foot shear strength) may have been a contributing factor in reducing sediment recovery by inhibiting penetration of the piston corer.

The sediment core for the pipeline bypass area, indicate that the sediments range very soft to soft clay, silty clays, and sandy clays. Minor inclusions such as seams and pockets of contrasting material were observed. Miniature vane shear strengths (undisturbed) ranged from 6 to 390 pounds per square foot. The location, core recovery, and description may be found in Table 3.5-1 below.

Table 3.5-1. Geotechnical Core Summary

Core Id a/	Easting (feet)	Northing (feet)	Recovery (feet)	Sediments Characteristics
L2 FLNG 1	1,297,412	177,627	4.0	Clay with silt traces at 0 to 2 feet with silt layers, sand pockets, and shell fragments to 0.5 foot grading to silty clay with shell fragments at 2 to 4 feet.
L2 FLNG 2	1,293,629	165,817	8.0	Sandy clay with shell fragments to 0.5 foot; clay with shell fragments 0.5 to 1 foot; and sandy clay with shell/shell fragments at 1 foot and 3 feet and gravel at 4 feet.
L2 FLNG 3	1,307,067	168,219	6.6	Clay at 0 to 2 feet with sand pocket and shell layers at 1 foot; and silty clay 2 to 6.6 feet.
L2 FLNG 4	1,303,234	156,223	4.5	Clay with silt traces at 1 foot and 2 feet.
1-A WC167	1,327,621	268,427	5.7	Clay with sand pockets at 0 to 0.5 foot; and sandy clay at 0.5 to 5.7 feet.

Note:
a/ This table contains data from the Applicant's proposed and bypass alternatives.

The geophysical evaluation indicated presence of sands and gravel, shells, and disseminated, low-pressure biogenic gas concentrations based on acoustic penetration and signal attenuation.

Two Holocene/Pleistocene buried channel systems were observed within the subbottom data within 25 ft of the seafloor. First generation, channels down cut from the unconformity approximately within 15 ft of the seafloor. Shallower second generation channels down cut from within the overlying Holocene sediments, within 2 ft of the seafloor. Channel fill material may exhibit geotechnical variability, including shear strength, bearing capacity, etc. over relatively small lateral and vertical extents. Sites selected for seafloor-based structures (i.e., support pilings for mooring structures) located totally outside the horizontal limits of the buried channels should not encounter significant difficulties.

Numerous amplitude anomalies were observed from 13 to 770 ft below the seafloor, the majority of which are within the uppermost 132 ft. The amplitude anomalies represent variations in sediment types and possible low-pressure biogenic gas concentrations.

In the area of the proposed Port, sediments are inferred to consist of varying combinations of relatively strong sandy and clayey strata (Fugro 2015d), analyzing geophysical and geotechnical data. Based on the understanding of the regional geology, over-consolidated clay "crusts," formed during periods of subaerial exposure during sea level regression.

In addition, the complex depositional history of the area, including multiple episodes of channel erosion and channel filling, results in noticeable horizontal and vertical stratigraphic variability over short distances.

A second round of sediment sampling was conducted in December 2015 in the proposed Port area. This evaluation was primarily to evaluate sediment chemistry; sediment cores penetrated to a maximum depth of 56 inches and averaged 31 inches, before refusal within a dense clay layer. Both visual and analytical laboratory assessment of grain size indicate the samples are fine sand, mixed with silt and clay. The cores also exhibited a thin, firm, fine-sand surface layer, with subsequent fine-grained compositions as depth increased. At core refusal depth, the confining layer consisted of extremely dense clay, sometimes intermixed with fine shell particles or crusty, firm “nodules.” The crusty nodules were rust colored, an indication of historical redox reaction of iron and oxygen in the deeper sediments. The cores exhibited a similar dark greenish gray color, and none smelled of hydrogen sulfide, a common indicator of the presence of organic activity.

3.5.5.3 Geophysical Investigation

To characterize the geology of the proposed Port area, an offshore geophysical and geotechnical survey was conducted between December 16, 2014, and February 15, 2015. Archaeological and geotechnical surveys were conducted in Federal waters within the Gulf of Mexico for:

- the proposed Port in WC blocks 319, 327, 328, and portions of WC 312, 313, 314, 318, 320, 326, 329, 333, 334, 335, and 336;
- Alternative Port 2 site in WC 359 and 374, and portions of WC 353, 354, 355, 358, 360, 373, 375, 376, 377, and 378; and
- the pipeline WC 167 bypass site.

The geophysical survey included bathymetric, sidescan sonar, magnetometer, subbottom profiler, and two-dimensional seismic data sets. The geotechnical survey included collection of sediment cores for sediment classification and geotechnical analysis.

The geophysical and geotechnical survey scope of work for the proposed Port was designed to meet or exceed requirements specified by BSEE NTL No. 98-20, “Shallow Hazards Requirements,” and NTL No. 2005-G07, “Archaeological Resource Surveys and Reports.” Survey equipment included a hull-mounted single-beam fathometer, a below-hull subbottom profiler, and towed sidescan sonar, magnetometer, and seismic sleeve (air) gun with 24-channel hydrophone streamer data sets. Sediment cores were collected using a gravity/piston core sampling system. Horizontal surface positioning was accomplished using a GPS corrected in real-time to ±1 m. Survey coverage of the proposed Port site consisted of 86 southwest-northeast primary track lines (Lines 100–185) spaced 150 m apart and 17 northwest-southeast tie-lines (Lines 200–216) spaced 900 m apart. Track lines with an S before the line number (Lines S100, S102, S104, etc.) are spaced 300 m apart where the seismic air gun system was collected along with the other systems. The remaining track lines were run with the bathymetry, pinger subbottom profiler, sonar, and magnetometer systems.

Navigational fixes (shot points) were recorded at 6.25 m and annotated every 20 navigational fixes on all data and study charts. Survey coverage of the proposed bypass site consisted of 49 southeast-northwest primary track lines (Lines 100–148) spaced 50 m apart, 3 southwest-northeast tie-lines (Lines 200–202) spaced 900 m apart, and 10 northwest-southeast in-fill track lines (Lines 300–309) spaced 50 m apart to survey gaps around the HIOS-Valve structures. The track lines were run with the bathymetry, pinger sub-bottom profiler, sonar, and magnetometer systems. Navigational fixes (shot points) were recorded and annotated at 125-m intervals. The charts enclosed in the geophysical survey reports (Fugro 2015a, b, c, d, e) include all track lines that provide coverage for the surveyed area.

Five gravity/piston sediment cores, one near each of the proposed mooring locations and one along the proposed WC167 bypass route, were collected with a modified Kullenberg Piston Corer. In order to determine geotechnical properties of sediments within the surveyed area. The geotechnical objective was to collect sediment cores 2.6 inches in diameter and 10 ft (3 m) in length from the top sediment (0–10 ft). Recovered cores were photographed, logged, and sampled for geotechnical analysis.

A second round of geotechnical sampling was performed in December 2015 to characterize the sediment composition and chemistry of the proposed Port area. A total of 14 sediment samples were collected at 0.5-mile intervals along the pipeline routes (proposed new laterals and bypass) and at each proposed TYMS location. Water samples were also collected at each of the general sediment locations from both surface and bottom depths as discussed in Section 3.2.5.4.

Sediment cores were collected using a vibracore system. The goal for each vibracore sample was a collection depth of 10 ft, or to refusal, at each sampling location. Physical core characteristics were analyzed in the field related to core recovery, texture, grain size, and color. Cores from each location were composited into single samples due to the homogeneous nature of the sediment for further analysis. All cores met with refusal at depths of 5 ft or shallower due to a dense layer of highly cohesive clay present. Samples were then prepared for shipment and sent to the appropriate laboratory under chain of custody for grain size and chemical analysis.

The description of the sediments indicate that surficial depths are dominated by clays and silts. Table 3.5-2 presents the grain size distribution for samples collected from the proposed Project area.

Table 3.5-2. Summary of Grain Size Descriptions of Collected Cores from Bypass Segment (N–2) and Lateral Locations (N–12)

Grain Size	Bypass Segment (N–2 Samples)		Lateral Segments (N–12 Samples)	
	Minimum Percentage (%)	Maximum Percentage (%)	Minimum Percentage (%)	Maximum Percentage (%)
Medium Grain Sand	2.2	3.1	0.4	2.4
Fine Grain Sand	27.4	38.6	23.1	61.9
Silt	30.5	33.6	25.3	39.8
Clay	25.6	39.0	17.2	36.3
TOC	0.295	0.347	0.241	0.660

Key:
TOC = total organic carbon
Full report is contained in Appendix H.

Grain size distribution is dominated by fine sands, silts and clays. Total organic carbon (TOC) in the sediments remained low and was consistently less than 1 percent in the sediments. This low TOC concentration is common in sediments rich in clay-dominated sediments of the southwestern Gulf of Mexico (Escobar-Briones and Garcia-Villalobos 2009). The clay-dominated sediments showed cohesive characteristics and were very plastic in texture. The location of these samples is presented in Figure 3.2-2 and the full report of this sampling effort is included in Appendix H.

3.5.5.4 Geologic Hazards

Potential geologic hazards generally include bathymetry, ground failure caused by unstable soils (slope instability), seismicity (earthquakes), shallow gas and gas hydrates, diapiric structures volcanism, or human activities (mining and blasting). The southern coast of the United States is a passive tectonic margin compared to an active tectonic margin like the western coast of North America which is subject to geologic uplift, volcanism and high levels of seismic activity. These hazards are summarized in Table 3.5-3 and discussed in detail below.

Table 3.5-3. Natural Subsurface Hazards Summary

Hazard a/	Definition	Identified / Description
Shallow faults, faulting attenuation	A fracture or fracture zone along which there has been displacement of the sides relative to one another, parallel to the fracture; attenuation is the translation of movement along a fault into surrounding mediums.	Present
Mass movement structures (slump, slide)	Often distinguished by a single coherent mass of material displaced from its original location, in which the sediment/rock mass remains virtually intact and moves outward and downward.	Not present
Diapiric structures	A type of intrusion in which a more mobile and ductily-deformable material is forced into brittle overlying strata; typically associated with massive mud or salt deposits at depth.	Not present
Shallow gas	Subsurface concentration of material in gaseous form that has accumulated by the process of decomposition of carbon-based materials (former living organisms, typically plants).	Present
Buried channels	Formerly the deepest portion of a waterway filled in with sediment over time and preserved to some extent by sea level rise and depositional processes.	Present; relict drainage pathways both shallow and deep
Note: a/ This table contains data from the Applicant's proposed and bypass alternatives		

Faults and Seismicity

A series of mostly seaward-facing normal faults borders the northern Gulf of Mexico. Rapid sediment deposition during Jurassic rifting caused sediments to collapse and spread seaward. Jurassic salt flowed southward and pierced upward into salt diapers, and the overlying sediments extended on listric, normal, growth faults that flattens downward into detachments in the salt and in over pressured shales. These listric normal faults, their splays, and their antithetic and transfer faults make up the belt of gulf-margin normal faults in the deeper sediments (Wheeler and Heinrich 1998).

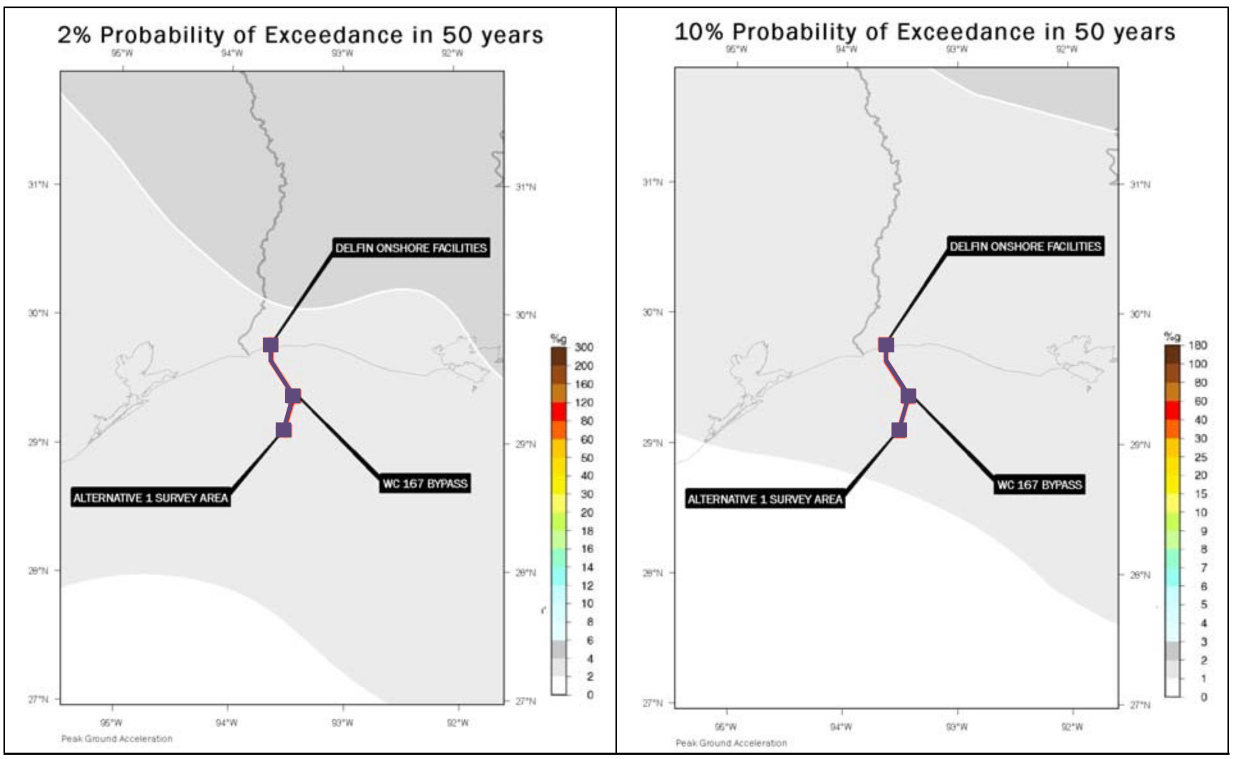
Quaternary gulf-margin normal faults is believed to be mechanically decoupled from the underlying crust as indicated by fault slips and well bore breakouts from deep drill-hole data (Wheeler and Heinrich 1998). The UTOS/HIOS pipelines crosses east-west trending growth faults located 13.5 miles, 32.3 miles, and 42.1 miles downstream of the proposed DOF. The closest mapped fault to the proposed Port is an east-west trending growth fault located 2.3 miles north of the north edge of WC 319 (USGS 2009). The four normal faults mapped during the survey of the proposed Port and proposed WC167 bypass exhibit relatively small offsets ranging from approximately 10 to 30 ft and none of the localized faults were located in the vicinity of the proposed mooring locations for the proposed Port or would be crossed by any of the four proposed pipeline laterals (Fugro 2015a).

Subbottom profiles acquired within the surveyed area displayed a maximum penetration of approximately 140 ft and consist of a thin layer of subparallel reflectors overlying acoustically amorphous deposits. The mapped structure horizon displays a very gentle regional dip of about 0.2 degree (18 ft/mile) to the south-southeast. The tops of four normal faults were observed at depths ranging from 3 to 970 ft below the seafloor. All four faults exhibit relatively small offsets at the mapped Structure Horizon ranging from approximately 10 to 30 ft. None of the localized faults were located in the vicinity of the proposed mooring locations or would be crossed by the pipeline laterals.

The Gulf Coast Basin has an overall a low incident of seismic activity. Only three earthquakes or tremors were reported in Louisiana in the twentieth century that were felt by persons. However, approximately 40 have been measured in or around the State, the largest on the Texas-Louisiana border with a body-wave magnitude of 4.4 during the construction of the Toledo Bend and Sam Rayburn reservoirs (Stevenson and McCulloh 2001).

The nearest recorded earthquake to the proposed Port site was a magnitude 3.8 that occurred on the east side of the Sulphur Salt Dome, causing hairline cracks in brick or stone fences (USGS 1987). Some of the sparse seismicity in the normal-fault belt may have been anthropogenic. Earthquakes of magnitude 4.0 and 4.7 in southeastern Texas and magnitude 4.9 in southwestern Alabama may have been induced by extraction of oil and gas or injection of fluids for secondary recovery, indicating the natural seismicity rate in the normal-fault belt might be even less than the recent historical record would indicate (Wheeler and Heinrich 1998).

The 2014 USGS Hazard Mapping Program probabilistic seismic hazard analyses for peak ground acceleration expected in the vicinity of WC 327, expressed as a factor of gravity (g), indicates 10 percent probability of exceedance is 0.01196g for within a 50-year period and 2 percent probability of exceedance of 0.02876g for within a 50-year period due to seismic events (Figure 3.5-1; USGS 2014a).



Source: USGS (2014a), expressed as a factor of gravity (g), the higher the percent the greater the acceleration.

Figure 3.5-1. Earthquake Probability

Salt Diapirs and Karst Deposits

Salt diapirism (the upward flow of Jurassic salts due to a density differential with surrounding sediments), can be beneficial to the petroleum industry because it creates structures that can serve as traps for petroleum. Salt structures can represent potential hazards, including activation of faults and fault scarps, slumping, and formation of shallow gas pockets, seeps, and vents.

There are no known salt diapirs located in WC 334, WC 327, WC 328, or WC 319. One salt diapir is crossed by the UTOS pipeline approximately 4.3 miles downstream of the proposed DOF (USGS 2009). Another salt diapir is centered in WC375,approximately 7 miles southeast of the proposed Port. Subsidence resulting from solution mining or erosion of salt diapirs poses no risk of subsidence at the proposed Port.

No karst terrain underlies the proposed Port area (Hosman 1996); therefore, there is no potential for subsidence due to collapse of karst structures.

Natural Gas

Variations in sediment types and possible low-pressure biogenic gas concentrations may be present in some areas identified in the geophysical survey. The front-end engineering design will evaluate these potential channels and amplitude anomalies and conduct additional geotechnical investigation and/or adjust orientation/position of mooring support structure as needed.

Gas hydrates are stable only under specific pressure-temperature conditions. Under the appropriate pressure, they can exist at temperatures significantly above the freezing point of water. At 80 ft of water, accounting for atmospheric pressure, the pressure would be 50.3 psi. The mean annual water temperature at this depth ranges from between 50 degrees Fahrenheit (°F) and 90°F. At 50°F, it would require 900 psi for methane to form gas hydrates, but natural gas components with heavier gas gravities (the molecular weight of the gas divided by that of air) of 1.0 would form hydrates at 180 psi. Methane has a gas gravity of 0.55. The proposed Port water depths range from approximately 64 to 72 ft, thus gas hydrates are not expected in shallow gas deposits.

Man-made Features/Paleontological Resources

Man-made features in the proposed Port area were recorded by magnetic signature or the subbottom profiler. Magnetometer data confirmed the position of the WC328 Removed "A" Structure. The well caisson at this location appears to be cut off beneath the seafloor and was not visible on the sonar data. WC318 Well No.4 (OCS-G-03802) and Well Nos. 6 and 7 (OCS-G-03802) were not confirmed with the collected survey data.

Subbottom profiler, sidescan sonar, and magnetometer data confirmed the location of the HIOS 42-inch pipeline S-7364. The as-built positions of the Energy Resources 6-inch (S- 15177) and 4-inch (S-15944) pipelines were verified with subbottom profiler, magnetometer and sidescan sonar data. The Energy Resources 6-inch (S-15177) pipeline exists approximately 1,750 ft southeast of the Core 1 location in WC334. The Energen Resources 6-inch S-8298 and Fieldwood Energy 4-inch S-18297 were verified with magnetometer and sonar data. The PG&E 4-inch S-8541 and Mariner 8-inch S-8022 pipelines were verified with magnetometer only. The location of the Energen Resources 6-inch S-6934 pipeline was not verified with the survey data.

A total of 195 unidentified magnetic anomalies were randomly scattered within the survey area for the proposed Port. The unidentified anomalies range in amplitude from 5 to 7,400 gammas and duration from 10 to 416 ft. Unidentified magnetic anomalies are presumed to represent articles of ferrous debris that are either buried below the sea bottom or too small to be acoustically detected, and can likely be associated with prior construction or passing ship traffic. Several large magnitude unidentified magnetic anomalies were recorded within WC 319, which was utilized for staging of drilling rigs in 1999. No sonar contacts were associated with these anomalies and possible ferrous sources may include anthropogenic debris associated with anchors and anchor buoys related to the parked rigs.

The existing HIOS Valve structure (OCS-G-04378), HIOS BS1 structure (OCS-G-07652), and HIOS FLR structure (OCS-00353) were also located and mapped. The database with this information been updated, and all charts reflect the updated positions of these pipelines. Magnetometer and pinger subbottom data confirmed and/or identified the position of the following pipelines: Enbridge 42-inch (S-4099), M21K 8-inch (S-10878), TC Offshore 30-inch (S-4659), and HIOS 42-inch (S-7364). Magnetometer, side scan sonar and subbottom pinger data confirmed and/or identified the position of the following pipelines: Kinetica 20-inch (S-12554), TC Offshore 16-inch (S-13646), and Apache 16-inch (S- 19140, etc.). No exposed pipelines were observed in the survey area. Pipeline confirmation utilizing sonar data identified pipeline trenches through differential reflection characteristics along the trench.

Magnetometer data identified 146 unidentified magnetic anomalies for the proposed WC167 bypass survey area within WC167. Magnetic anomaly No. 115 has been assigned an avoidance radius of 150 ft.

No existing infrastructure and no significant unidentified magnetic anomalies or sonar contacts are located at the proposed mooring locations or pipeline laterals on the proposed pipeline bypass route.

Paleontological resources are the fossilized remains of prehistoric plants and animals, and the trace fossils left as indirect impressions of the form and activity of such organisms. These resources are considered to be nonrenewable resources. Based on a review of available geologic data, no potentially significant fossils or sensitive paleontological resources are present.

3.5.5.5 Mineral Resources

Based on review of available geologic data, no currently exploitable mineral resources such as minable quantities of sand and gravel are present within the proposed Port. The cores taken in the area during the geophysical survey and sediment sampling investigation clearly confirm this.

In respect to oil and gas the proposed Port is located in the western portion of the Mesozoic Deep Shelf play (an area of similar potential for oil and gas). The play is a series of large, four-way dipping structural closures of source, reservoir, and seal lithology's that comprise 6.5 million acres of seismically correlated units of Upper Jurassic through Upper Cretaceous age. While this is a recognized potential play, there are no proven or unproven reserves on the entire play extent to date (BOEM 2012b). Blocks to the north, northeast, and east are currently up for lease sale/renewal for oil and gas exploration and production and have existing infrastructure (BOEM 2015).

3.5.5.6 Marine Sediment Quality

The Mississippi River is the primary water body that affects physical, chemical, and biologic conditions in the environs of the proposed Port area. The Mississippi River is 2,302 miles (322 km) long and drains parts or all of 31 States. The river discharges 612,000 cubic feet (ft^3) of sediment-laden water per second into the Gulf of Mexico. Therefore, the discharged water is very turbid and high in nutrients, principally nitrogen and phosphorus. These nutrients at many times of the year the nutrient level is so high that an area of hypoxia (i.e., devoid of oxygen) forms south of the Mississippi River Delta, commonly referred to as the "Dead Zone," in which the proposed Port site is located.

The northern Gulf of Mexico adjacent to the Mississippi River is the largest "Dead Zone" in the United States. In 2015, this "Dead Zone" covered 6,474 square miles, significantly above the 2014 area of 5,052 square miles caused by heavy June rains throughout the Mississippi River watershed and above normal flow from the river.

"Dead Zones," or hypoxic zones, are caused when the concentration of DO in the water column and sediments decreases to a level that can no longer support living aquatic organisms. This level is often defined as when the DO concentration is approximately 2 milligrams per liter (mg/L) or less. In the same way that nitrogen and phosphorous fertilize human crops, they also fertilize plants in the ocean, causing significant growth of algae. The spring delivery of nutrients initiates a seasonal progression of biological processes and when algae and bacteria on the ocean floor decompose the abundant carbon consumes the oxygen. Organisms capable of swimming (i.e., fish, shrimp, and crabs) evacuate the area, but less mobile fauna experience stress or die as a result of low oxygen. Hypoxia can persist several months until there is strong mixing of the ocean waters, which can come from a hurricane or cold fronts in the fall and winter.

The boundaries of this "Dead Zone" as determined by the USEPA (2016) migrate based on river discharge, nutrient loading, and ocean currents and are delineated based on a concentration of 5 mg/L. In the summer of 2015, although the proposed Project was not located within an area meeting hypoxic conditions (less than 2 mg/L), the site was within the USEPA-defined "Dead Zone" of under 5 mg/L (see Figure 3.5-2).

However, as depicted in Figure 3.5-2, hypoxic conditions have shifted into the waters surrounding portions of the proposed Project, as was the case during the summer of 2014.

In addition, toxic substances and pesticides are also discharged into Gulf of Mexico from industrial and municipal discharges, urban and agricultural runoff, accidental spills, and atmospheric deposition. Therefore, sediments in the Mississippi River delta contain industrial byproducts, pesticides (e.g., chlorinated organic compounds), and trace metals that could enter the water column if sediments are disrupted. Depending on cycling of the movement of waters within the estuarine habitat, these toxins can bioaccumulate in indigenous biota and allow for introduction into the local food chain.

Bio-availability of these contaminants is dependent on sediment characteristics, including concentrations of TOC (for hydrophobic organic compounds) and acid-volatile sulfide (for divalent metals). Some chemicals are acutely toxic while others may have chronic toxicological effects that affect organism growth or reproduction. Bio-accumulative organic compounds and metals can also be bio-concentrated or biomagnified and transferred through the marine food chain.

Recent sampling efforts by the LDEQ have shown contaminants to exist in the sediments, but their levels are well below USEPA guidelines (Caffey et al. 2002). NOAA's National Status and Trends Mussel Watch Program continually monitors organic and metal contamination in coastal sediments and bivalve mollusks. Mollusks and other benthic organisms have been shown to be efficient accumulators of toxic contaminants. Mercury is a highly toxic heavy metal that has been shown to be both a natural and anthropogenically introduced contaminant. Generally, both sediment and tissue mercury contamination along the Louisiana coast have been shown to be low (Karnauskas et al. 2013). Similarly, cadmium contamination is important because of its potential toxicity to both humans and wildlife. Cadmium contamination is almost solely anthropogenic in origin, and sediment concentrations have been found to significantly correlate with human population and urban development. Generally, cadmium concentrations in tissues have decreased from the 1990s, but it is still a metal of concern (Karnauskas et al. 2013).

Turner et al. (2003) analyzed shelf sediments off the coast of Louisiana and found trace organic pollutants, including PAHs, herbicides such as Atrazine, chlorinated pesticides, PCBs, and trace inorganic (metal) pollutants. The offshore oil and gas industry operates hundreds of platforms throughout this portion of the Gulf of Mexico. Many platforms have discharges of drilling wastes, produced water, and other industrial wastewater streams that have adverse impacts on water quality. The USEPA regulates the discharge of these wastes through NPDES permits. Except in shallow waters, the effects of these discharges are generally localized near individual points of discharge (Neff 2005).

The detection of organochlorine pesticides and PAHs in sediment cores collected in water depths of 33 to 330 ft (10 to 100 m) off the southwest pass of the Mississippi River showed an increase for those deposits after the 1940s (Turner et al. 2003). The river was identified as the primary source of both organochlorine and the pyrogenic PAHs, which are associated with the burning of fossil fuels. However, higher concentrations of petrogenic PAHs, which are associated with natural seeps and/or oil and gas exploration, were found farther from the mouth of the river (Turner et al. 2003).

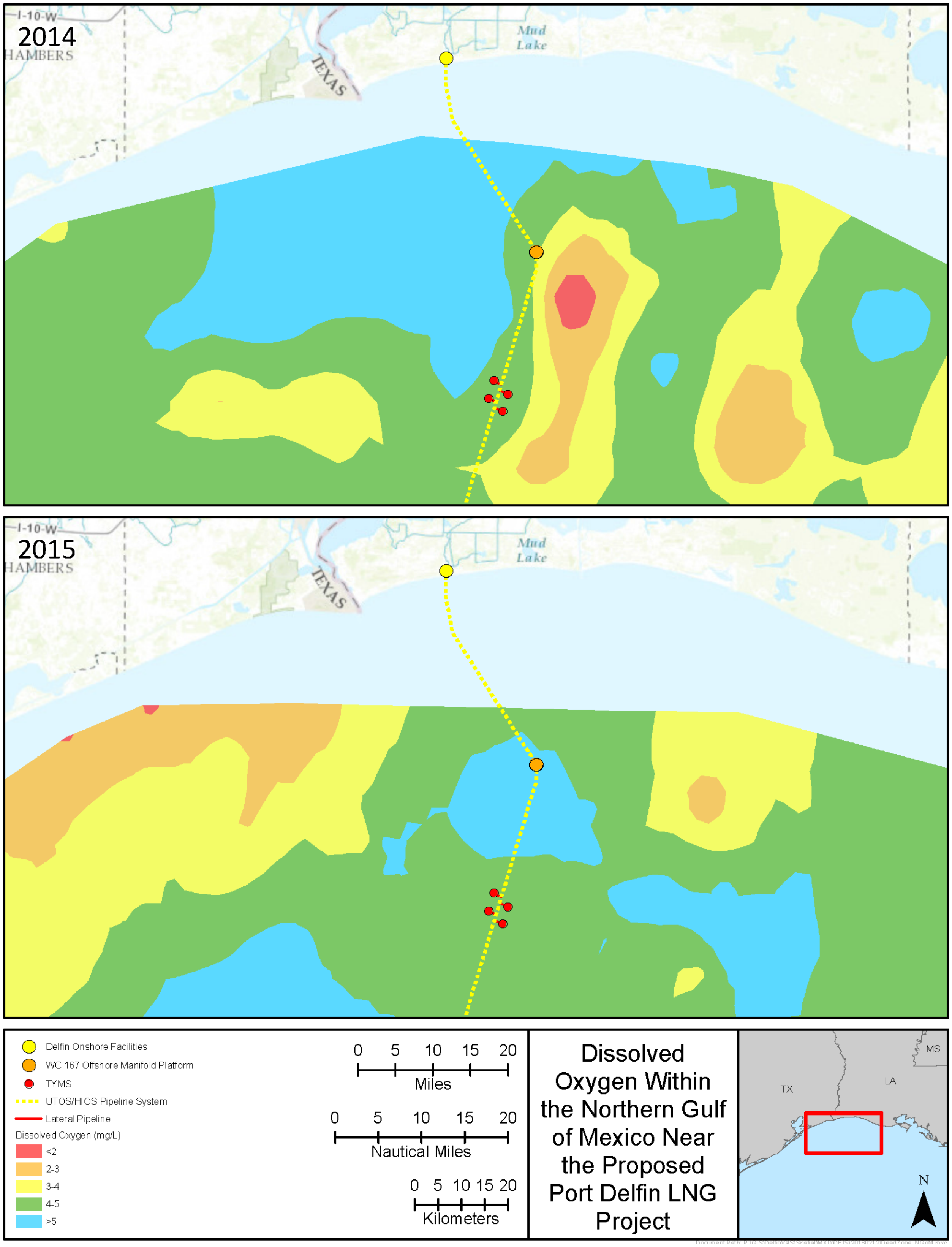


Figure 3.5-2. Dissolved Oxygen within the Northern Gulf of Mexico Near the Proposed Port Delfin LNG Project

In order to characterize the existing sediment quality within the proposed Project area, 14 (+ duplicate) sediment core samples were collected for chemical analysis during the period of December 15-16, 2015. These samples were collected at the same locations that were also identified for water quality samples and geotechnical samples discussed in Sections 3.2.5.4 and 3.5.5.3, respectively. Analytical parameters analyzed for sediment quality included TOC, Resource Conservation and Recovery Act metals (arsenic, barium, cadmium, chromium, lead, mercury, selenium and silver), total PCB aroclors, pesticides, PAHs, volatiles (benzene, ethylene, toluene and xylene), dioxins and furans, and sediment grain size.

Analytical results showed that sediments found throughout the sampling area consisted of very limited quantities of TOC (mean of less than 0.5 percent by weight), low moisture content (mean of 26.7 percent by weight), and grain size distributions containing high percentages (more than 60 percent) of silt and clay. Analytical results from the December 2015 sampling results can be found in Appendix H.

All of these samples contained naturally occurring, and possibly anthropogenically derived, inorganic compounds, including arsenic, chromium, and lead. Cadmium was found at most locations, silver was detected at a few stations, and, not surprisingly, barium was found in all sediment samples. Silver was detected at less than half the sample locations, with the highest concentration of approximately 0.1 milligrams per kilogram (mg/kg). Mercury was detected at all sample locations and averaged 0.012 mg/kg. Except for a limited number of PAHs and numerous detections of dioxins and furans, all other organic compounds (pesticides, PCBs, and volatiles) were not detected in sediments.

Dioxins are formed from the incomplete combustion of organic material in the presence of chloride. Their extent throughout the Gulf of Mexico is likely derived from multiple sources associated with both the offshore oil and gas industry, as well as from land-based sources, including waste handlers and combustion facilities. Dioxins can be emitted to the air via many sources, sequestered in sediment, and persist for long periods of time.

Detected concentrations (low-level detections of select PAHs, metals, and dioxins/furans) were compared to Effects Range-Low (ERL) and Effects Range-Median (ERM) or equivalent values listed in Buchman (2008). Exceedance of ERL values indicate the potential for impacts on benthic communities but is not considered to be confirmative that impacts are occurring. Exceedance of the ERM value (or its equivalent benchmark) indicates that impacts are likely occurring but does not confirm these impacts are present. Results of the comparisons revealed the ranges of concentrations to be below detection limits or remain below corresponding ERLs and ERMs for the chemical constituents analyzed. ERL values for dioxins and furans as toxicity equivalency quotients (TEQs) were exceeded at select stations for these compounds. Dioxins and furans were than evaluated as total concentrations for each sample. Prior to summation, a Toxic Equivalency Factor (TEF) for fish was applied to each conjugate in order to report the toxicity-weighted masses of the mixtures of dioxins/furans. Dioxin/furan TEQ calculations were replicated using the original sediment sample analysis data and the TEFs for fish (Van den Berg et al. 1998) were applied and the total dioxin/furan concentrations and were reported for each sample location (Appendix H). Results of the sediment sampling analysis indicate that contaminants at the sampling stations were low and not indicative of significant contamination; therefore, impacts on water quality from resuspension of sediments are not expected to be adverse.

3.6 Offshore Cultural Resources

This section is limited to discussion of offshore cultural resources; cultural resources located onshore are addressed in Section 3.14.

3.6.1 Definition of the Resource

Cultural resources include archaeological sites (prehistoric and historic; terrestrial and marine), historic standing structures, objects, districts, traditional cultural properties, and other properties that illustrate important aspects of prehistory or history or have important long-standing associations with established communities or social groups. Significant archaeological and architectural properties are usually defined by eligibility criteria for listing on the National Register of Historic Places (NRHP) and in consultation with the Louisiana Office of Cultural Development, Division of Historic Preservation, which functions as the State Historic Preservation Office (SHPO) in Louisiana. As lead Federal agencies, the USCG and Maritime Administration (MARAD) would determine if the permitting of the proposed Project would adversely affect cultural resources that are listed in or potentially eligible for listing on the NRHP. The area of potential effects (APE) on archaeological resources for the proposed Port, as specified in Section 106 of the National Historic Preservation Act (NHPA), includes all marine locations that would undergo project-related disturbance that could result in changes in the character or use of historic properties. In addition, under the NRHP, undertakings include new and continuing projects, activities, or programs and any of their elements not previously considered under Section 106.

3.6.2 Required Permits

No permits specifically regarding cultural resources would be required; however, projects that would be considered a Federal undertaking such as this proposed Project (i.e., projects that require Federal permits, receive Federal funding, or occur on Federal lands) require consultations by the lead Federal agency with SHPO, and interested Native American tribes under Section 106 of the NHPA of 1966 (as amended). The Federal agency must take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion on the NRHP. The Advisory Council on Historic Preservation (ACHP) must be given an opportunity to comment on the project.

3.6.3 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to offshore cultural resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- NHPA Section 106;
- EO 11593, Protection and Enhancement of Cultural Environment;
- Historic Sites Act of 1935 (16 U.S.C. 461 et. seq.);
- Determination of Eligibility for Inclusion on the NRHP (36 CFR 63);
- Recovery of Scientific, Prehistoric, and Archaeological Data (36 CFR 66);
- Curation of Federally Owned and Federally Administered Archaeological Collections (36 CFR 79);
- Protection of Historic Properties (36 CFR 800);
- Guidance issued to oil and gas companies by the Bureau of Ocean Energy Management (BOEM) and the Bureau of Safety and Environmental Enforcement (BSEE):
  - NTL No. 2005-G07,
  - NTL No. 2008-G05, and
  - NTL No. 2011 – Joint – G01;
- Abandoned Shipwreck Act of 1987 (43 U.S.C. 2101 et. seq.); and
- The Louisiana Archaeological Resources Act (Title 41 Chapter 13 § 1601, et seq.).

3.6.4 Existing Threats

Cultural resources in the Gulf of Mexico risk impacts from fishing, farming, treasure hunting, illegal salvage of shipwrecks, sand/gravel/mineral extraction during dredging projects, and energy development. While the existing offshore oil and gas industry is often portrayed as the largest threat to these resources, this industry is heavily regulated through BOEM, which requires archaeological surveys and avoidance of submerged cultural resources (Evans et al. 2009). Dredging projects are also typically regulated by BOEM or the USACE.

3.6.5 Existing Conditions

Existing conditions include any offshore cultural resources that may exist within or in the vicinity of the proposed Project location and are discussed in the following subsections.

3.6.5.1 Cultural Context

Prior to submersion by the rise of the sea level during the early Holocene, the continental shelf was exposed land surface interspersed with bays, estuaries, streams, and wetlands. Land areas near such features would have been available to early pre-contact Native American hunter-gatherers who may have lived seasonally in the area of the APE. The continental shelf was completely submerged by rising ocean levels sometime after 8,250 years before present (B.P.). As the continental shelf portions of the APE became submerged due to rising sea levels, Native Americans and later Euro-Americans may have traveled the waters that are now part of the Gulf of Mexico during episodes of resource extraction, trade, and long- and short-distance travel. Remnants of various types of vessels, vessel fragments, and possibly other associated cultural items could be contained within the APE.

The earliest known habitation of North America was by small groups of hunters and foragers who occupied a variety of areas across the continent during the late Pleistocene and early Holocene periods. These areas would have been characterized by floodplains and river valleys during the earliest potential Paleo-Indian occupations of the northern Gulf of Mexico, from about 12,000 to 8,250 years ago. Landforms would have varied from approximately 5 to 25 m above sea level. By the end of the time period, the continental shelf would have been completely inundated due to the rising of the ocean level. The former land surfaces and associated land features have since been exposed to erosion and reworking of levees due to subsurface conditions and storm patterns over time. Submerged landforms that include floodplains, river terraces, point bars, bays, lagoons, ponds, subsiding deltas, and sinkholes that may be identified represent locations with the highest probability areas for discovering potential prehistoric archaeological sites.

Human occupation of the Gulf Coast of North America by 12,000 years B.P. is documented by the pre-Clovis site Page-Ladson site in Florida. Other sites, such as Avery Island in Louisiana and the Wascissa River and the Little Salt Spring site in Florida, are related to the time period characterized by a distinctive tool kit referred to as the Paleo-Indian Period (12,000 – 10,000 B.P.). Sites characteristic of the subsequent cultural period, the Archaic Period (10,000 to 3,000 B.P.), are also known along the Gulf Coast on terrestrial landforms that are now submerged. These areas were likely bays, estuaries, streams and wetlands. Following transgression by the rising sea level, storm patterns and subsurface conditions resulted in erosion and reworking of natural levees that would have been present during prehistoric occupations.

Following inundation of the continental shelf by rising ocean levels, Native Americans and later Euro-Americans may have travelled the waters that are now part of the continental shelf and the Gulf of Mexico. It is possible that any vessels that may have been used following the Archaic Period to modern day could potentially be represented in the archaeological record in the submerged APE. Remnants of various types of vessels, vessel fragments, and possibly other associated cultural items could be contained within the APE portions of the Outer Continental Shelf (OCS) and the coastal zone. From the mid-1500s through to the mid-1800s, Spanish navigators crossed through the area of the OCS and Gulf of Mexico, including the APE. Sailing ships encountered numerous weather events and unmapped navigational hazards that resulted in shipwrecks. Trade vessels were also affected by threats due to piracy, which could also have resulted in wrecks or loss of property from vessels and thus loss in the submerged area of the OCS and Gulf including the APE. Records of vessel sinkings may not reflect the actual number of vessels that may remain submerged. At least seven shipwrecks have been reported near the proposed Project and 13 shipwrecks reported near the proposed WC 167 bypass, all with various degrees of location reliability.

3.6.5.2 Offshore Cultural Resources Assessment

Detailed archaeological and hazard surveys for the proposed Project were performed in December 2014 and January and February 2015 by Delfin LNG in compliance with guidelines and requirements of BOEM and the Bureau of Safety and Environmental Enforcement (BSEE) in accordance with the Mineral Management Service NTLs Nos. 2008-G05, 2005-G07, and 2011-Joint-G01. Delfin LNG applied information derived from known prehistoric site locations and terrestrial predictive models of prehistoric site locations to its assessment of the submerged continental shelf crossed by the proposed Project. The data formed the basis for identification of areas where potentially submerged prehistoric sites may be located and possibly affected by the proposed Project.

The results of geophysical and geotechnical surveys of the proposed Project were used to identify the presence of submerged intact landforms that were exposed prior to Holocene marine transgression and that could potentially contain intact archaeological remains. The seafloor was exposed from at least 70,000 years ago to 12,000 years B.P. during the Late Wisconsin Glacial Stage. The rising sea level eventually inundated the continental shelf by about 8,250 B.P. when the area was converted into a gradually deepening marine environment as exists today.

The geophysical and geotechnical surveys of the proposed Project’s floating liquefied natural gas vessel mooring areas revealed reworked Pleistocene top soils that were abraded by sea level transgression starting around 8,250 years B.P. Repetitive grinding of the shoreline sands/shell hash and associated longshore current have completely abraded former fluvial bedding at the seafloor. Profiles do not exhibit preserved alluvial deposits where archaeological sites could exist. Therefore, the potential for discovering intact archaeological sites related to prehistoric time periods is low in this area. No evidence of natural levees or embankments suitable for prehistoric human habitation was noted. No landforms that could be characterized as high probability for finding prehistoric sites were identified from the sub-bottom profiles.

In the pipeline bypass survey area near WC 167, sediment profiles revealed low sediment deposition and erosion of deeper strata from ocean wave action and bottom currents over time. Surficial soils have been reworked by sea-level transgression since 8,250 years B.P. The geophysical data within the pipeline bypass survey area indicated no evidence of natural levees or embankments and no isolated landforms identified from subbottom profiles that indicate potential locations of prehistoric sites.

A total of 22 sonar contacts and 195 unidentified magnetic anomalies were identified throughout the proposed Project survey area. Three recorded magnetic anomalies correspond to sonar contacts. Each varies in size and displays no relief off the sea floor, suggesting the potential for archaeological origin. These three locations would be avoided by the proposed Project. The remaining unidentified magnetic anomalies are presumed to be ferrous debris probably associated with passing ship traffic or prior construction. Four large magnitude unidentified magnetic anomalies were recorded within an area formerly used as a temporary staging area for drilling rigs.

In the pipeline bypass survey area, 318 magnetic anomalies and 52 sidescan sonar contacts were recorded. Nine sonar contacts are associated with unidentified magnetic anomalies. One set of these associated contacts appears to be the main portion of an extensive debris field that may relate to a severely damaged shipwreck site. The shipwreck may represent the remains of a steel- or wooden-hulled steamship that plied the Gulf of Mexico in the service of Charles Morgan’s Louisiana & Texas Railroad Steamship Company (1837–1885). The condition and orientation of the sonar contacts resemble the wreck site and debris field of the steamship *New York*, destroyed by a hurricane on September 7, 1847, en route from Galveston, Texas, to New Orleans, Louisiana. Seventeen passengers and crew were lost. The wreck is eligible for listing on the NRHP (Irion and Ball 2001). A radius of 1,000 ft around the contact has been defined as a zone of avoidance so that this potential cultural resource may be avoided by the proposed Project. Smaller zones of avoidance radii, 300 ft and 100 ft respectively, have also been established around two additional sonar contacts that have associated magnetic contacts and that are interpreted as related to potential archaeological sources such as possible shipwrecks.

3.7 Ocean Uses, Offshore Recreation, and Offshore Visual Resources

This section is limited to discussion of ocean uses, offshore recreation, and offshore visual resources; land use, onshore recreation, and onshore visual resources are addressed in Section 3.15.

3.7.1 Definition of the Resource

Ocean use refers to the various ways in which areas within the Gulf of Mexico might be used or developed, the kind of activities allowed, and the cover type. Oil and gas activities and marine shipping industries dominate the current use and future development plans for offshore Gulf of Mexico areas. Other activities present in offshore areas of the Gulf of Mexico include military training and commercial and recreational fishing. Offshore cover types in the Gulf of Mexico include soft bottom sediment, naturally and artificially occurring reefs, sand resource areas, hard bottom, and submerged aquatic vegetation. The area shorelines include a mix of residential developments, open spaces, and industrial land used for manufacturing, marine, shipping, agricultural, and oil and gas development activities.

Recreation resources are both natural and man-made entities, which offer visitors and residents diverse opportunities to enjoy leisure activities. Offshore recreational resources include marine sanctuaries, estuarine bays, and areas for recreational fishing, boating, and water sport activities.

Visual resources refer to the composite of basic terrain, geologic features, hydrologic features, vegetative patterns, and man-made features that influence the aesthetic character and quality of an area. NEPA regulations (40 CFR §1508.8) require that aesthetic impacts be identified and considered when determining project impacts. Marine areas offer visual resources to boaters, birds, and beachgoers. Visual impacts are a function of the visual resources present as well as the number, preferences, and sensitivity of potential viewers.

3.7.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to ocean use, offshore recreation, and offshore visual resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- CZMA,
- Submerged Shelf Lands Act,
- Outer Continental Shelf Lands Act,
- Louisiana State and Local Coastal Resources Management Act of 1978, and
- Texas Coastal Coordination Act of 1991.

3.7.3 Required Permits

No specific permits are required.

3.7.4 Existing Threats

Existing threats include commercial and private vessel traffic, including traffic to and from offshore development areas and shipping. Extreme weather conditions such as hurricanes can negatively impact ocean use and recreation. Anthropogenic threats such as oil spills can have a severe impact on ocean use as well.

3.7.5 Ocean Uses

The coastal waters of the Gulf of Mexico south of the state of Louisiana have a long history that features nearly all conceivable maritime uses. Not only are commercial maritime activities crucial to the state of Louisiana, but the maritime infrastructure of Louisiana is critical to the economy of the nation at large. Each year, the Port of South Louisiana ranks atop the list of U.S port facilities on a pure tonnage basis. In addition, the ports of New Orleans, Baton Rouge, Plaquemines, and Lake Charles are all also featured near the top of this list (Bureau of Transportation Statistics n.d.). Despite the many other ways in which the U.S. economy has evolved away from traditional infrastructure, the Port of South Louisiana, for example, increased its shipping volume by 20 percent from 2003 to 2013, indicating that this is actually a period of growth in the traditional mercantile shipping industry.

The maritime safety fairway system that exists in the proposed Project area was designed to keep all mariners in the area safe while operating offshore. Technical tools such as the Automatic Identification System (AIS) and integrated chart plotter/radar/Global Positioning Systems (GPS) installed on the bridge of nearly all commercial vessels have also contributed to creating a safer maritime environment by facilitating the acquisition of knowledge of existing offshore infrastructure. The USCG and their system of Notices to Mariners is yet another way that commercial vessels are kept informed of any possible alterations to plotted infrastructure and those that are likely to be seen utilizing it.

Existing petroleum infrastructure is another critical part of the offshore maritime community in this portion of, as well as throughout, the Gulf of Mexico. Louisiana ranks behind only its Gulf coast neighbor, Texas, with respect to gasoline refineries and production. Louisiana and Texas are both in Petroleum Administration for Defense District (PADD) 3, which has the highest output for crude oil production in the United States. In 2015, Louisiana produced 173,000 barrels of crude oil per day (ninth highest in the United States) and Texas produced nearly 3.5 million barrels of crude oil per day (highest in the United States). Crude oil production offshore in PADD 3 accounted for 16 percent of production in the United States in 2015 (EIA 2016a). From a natural gas perspective, this area of the United States is also quite robust judging both by resource and infrastructure. Figure 3.7-1, a natural gas facilities map from the U.S. EIA, depicts the current amount of installed infrastructure in the proposed Project region.

The continued exploration of the Gulf of Mexico, the increased dependence upon natural gas by the U.S. market, and the ongoing Federal leasing process ensures that this industry will remain a going concern for many years to come. The combined sphere of influence associated with the petroleum industry on this offshore environment, from physical offshore facilities to the support infrastructure to charted anchorages, lightering areas, and dump sites, is unlike any other coastal area in the United States.

Considering the offshore wind resource at 90 m above the surface within 50 nautical miles of coastal Louisiana, there are 18,550 square miles of water for annual average wind speeds between 7.0 and 7.5 m/s with a total potential installed capacity of 240.2 gigawatts and 5,804 square miles of water for annual average wind speeds between 7.7 and 8.0 m/s with a total potential installed capacity of 75.2 gigawatts. Unlike other offshore coastal areas, there are no areas with annual average wind speeds above 8.0 m/s. There currently are no wind projects offshore of Louisiana, largely due to the cost of development.

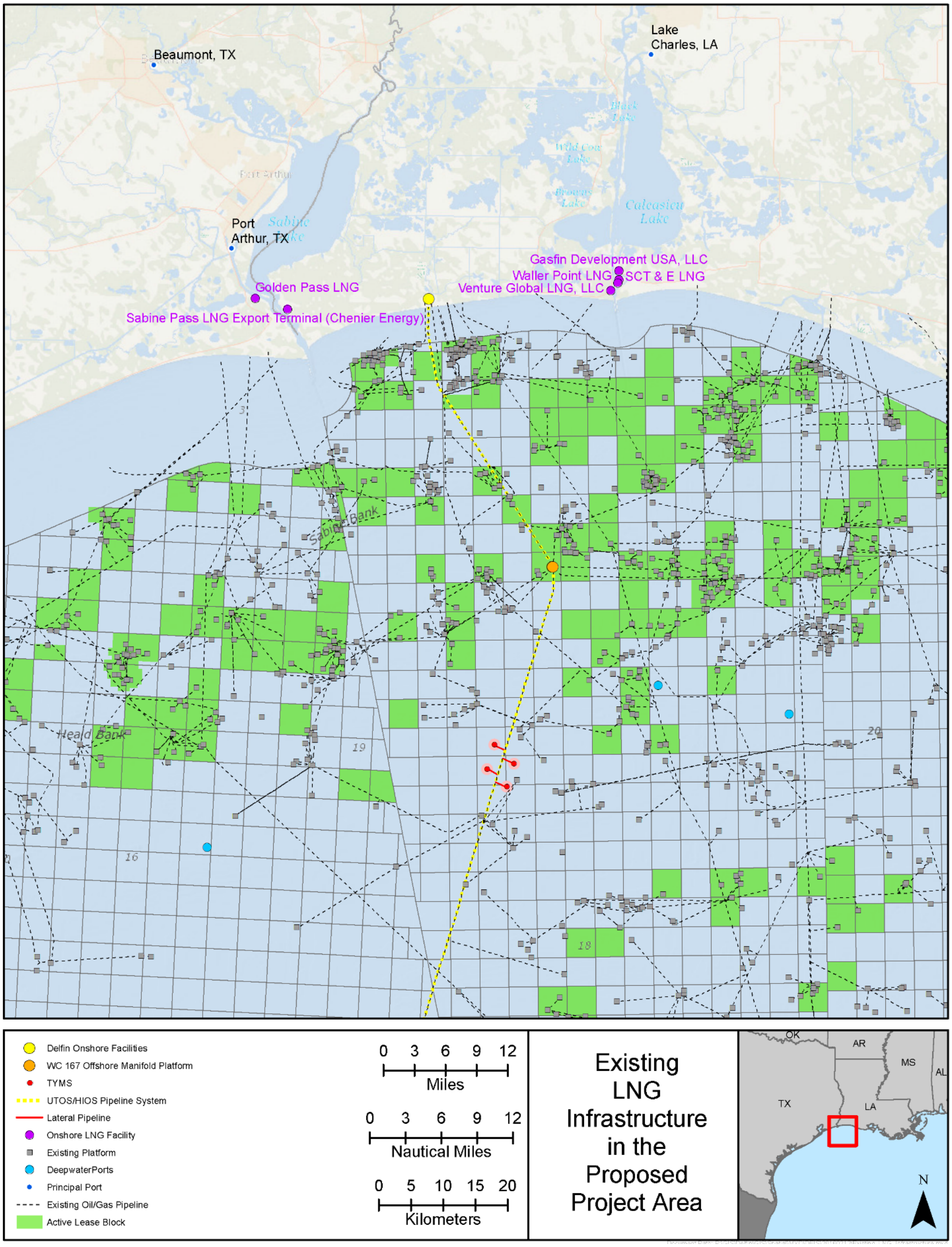


Figure 3.7-1. Existing LNG Infrastructure in the Proposed Project Area

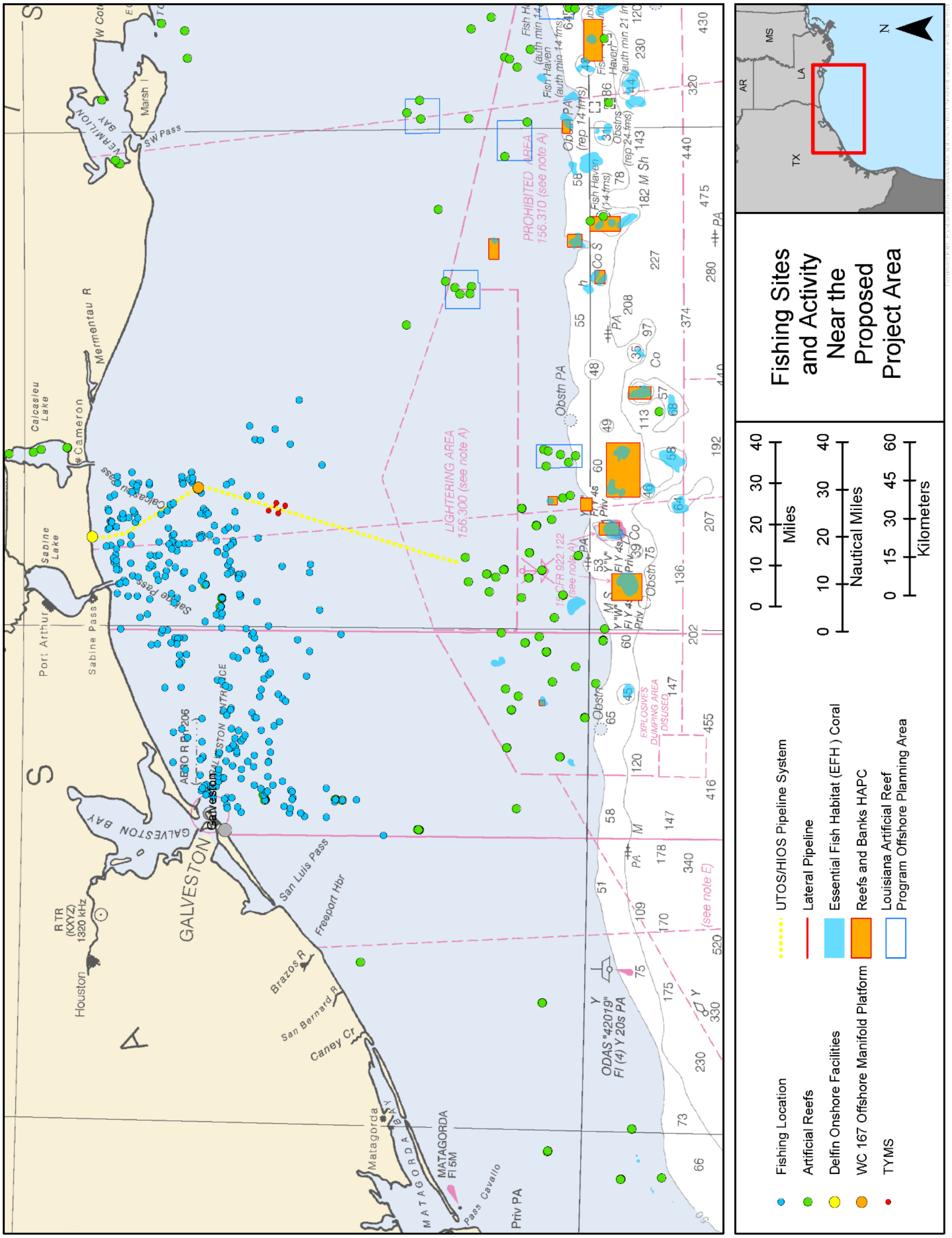
3.7.6 Offshore Recreation Resources

In addition to the marine uses referenced above, this area of the Gulf of Mexico also contains recreational areas used for a variety of purposes. Areas of natural seabed structure and man-made seabed features are the areas most often targeted by commercial and recreational fishermen as well as divers. One example from within the proposed Project area is Sabine Bank. Sabine Bank was a traditional fishing ground of the Louisiana (and Texas) coastline and an area once known for producing abundant red snapper in fairly close proximity to the coast (13 nautical miles [25 km] offshore). This occurred mostly in the mid-1900s though it is still fished today. It was once a location where fish aggregated simply because it was a shoal or bank 10 to 15 ft shallower than the surrounding seabed. Today, however, it remains a natural shoal but also contains ship wrecks, dump sites, fairway buoys (and their chains and moorings), as well as petroleum facilities both active and defunct. Fish havens have also been created along the perimeter of the bank presumably to enhance marine productivity by expanding this seabed feature. This single seabed area represents an array of past and present maritime uses and serves as a microcosm for the proposed Project area and this part of the Gulf of Mexico as a whole.

3.7.6.1 Recreational Fishing and Boating

The majority of recreational boat trips taken in the proposed Project vicinity are for the purpose of recreational fishing, which is a year-round activity in the Gulf of Mexico off the coast of Louisiana. Recreational boaters in the proposed Project vicinity may use several launch points for single-day trips in waters offshore Cameron Parish, including six public recreational boat launches in Cameron Parish as well as boat launches in Calcasieu, Jefferson, and Vermillion Parishes, Louisiana and Jefferson County, Texas.

Recreational fishing in the vicinity of the proposed Port Delfin site would be considered offshore fishing because of the water depths, which range from 64 to 72 ft and may, therefore be conducted by anglers from any number of Louisiana ports. Targeted species in the area near the proposed Project would be a mix of offshore species like King mackerel (*Scomberomorus cavalla*), Spanish mackerel (*Scomberomorus regalis*), cobia (*Rachycentron canadum*), red snapper (*Lutjanus campechanu*), assorted groupers (*Mycteroperca* spp.), amberjack (*Seriola* spp.), assorted sharks, and other species of opportunity. It is accurate to state that the majority of well-known and heavily utilized recreational fishing destinations are in and around the Mississippi delta, over 100 nautical miles from the proposed Project area to the east, or in and around Galveston, Texas, 60 nautical miles to the west (see Figure 3.7-2); however, Galveston vessels may fish in and around the proposed Project area.



Source: textfishingmaps.com

Figure 3.7-2. Fishing Sites and Activity Near the Proposed Project Area

Despite the fact that fishing locations exist in and around the proposed Project area, it is noteworthy that there is a far higher density of fishing locations in Figure 3.7-2 in closer proximity to Galveston and that there are many fishing locations that sit outside of the proposed Project area. The southwestern Louisiana coast in general, however, is not that part of Louisiana that falls under the moniker of "Sportsman's Paradise." There are very few recreational vessel ports along the western Louisiana coastline and few others exist up rivers or within the inshore, estuarine environment. Compared to the Mississippi delta ports such as Venice over 200 nautical miles away where recreational fishing generates $2 billion in sales and 18,000 jobs, western Louisiana's recreational fleet is all but non-existent (see Figure 3.7-3).[20]

Figure 3.7-3. The Pilot Station in Cameron, LA (left) and Venice Marina (right) – One of the Top Recreational Fishing Ports in the United States

3.7.6.2 Artificial Reefs and Scuba Diving

As discussed above, active and abandoned oil and gas platforms may function as artificial reefs, enhancing marine fisheries and associated offpg 3-69

shore recreational activities, through the Louisiana Artificial Reef Program. There are no converted platforms near the proposed Project area that are part of decommissioned platforms eligible for conversion in-place into the Louisiana Artificial Reef Program. The nearest convert platforms is over 50 nautical miles southeast, at the southernmost edge of the East Cameron protraction area.

Scuba divers may transit the Gulf of Mexico; however, heightened security risks after the September 11, 2001, terrorist attacks as well as damage caused by Hurricanes Rita and Katrina in 2006 and the BP oil spill in 2010 have diminished the volume of diving offshore of Louisiana. Scuba divers have been known to dive around inactive rigs that have not been converted as part of the Louisiana Artificial Reef Program, both as private divers and as part of trips organized by local dive shops. There are no inactive platforms within 10 miles of the proposed Port; however, there are six unmanned, active platforms within this radius. Because these platforms are active, they would not be candidates for scuba activities and they could not be converted in place through the Louisiana Artificial Reef Program when they become inactive as they are below the threshold water depth for the program.

3.7.6.3 Cruise Ships

Ocean-going passenger vessels, including cruise ships, are more likely to use the Ports of Galveston and Houston on Galveston Bay and the associated fairway that terminates at the entrance of Galveston Bay, rather than the Sabine-Neches Waterway or the Calcasieu Ship Channel. Neither the Sabine-Neches Waterway nor the Calcasieu Ship Channel have ports that regularly receive cruise ships engaged in multi-day trips. Further, vessels that travel east–west along the section of the Gulf Coast near the proposed Port navigate in or near the defined

[20] http://www.nmfs.noaa.gov/mediacenter/2013/03/07_noaa_report_finds_commercial_and_recreational.html

shipping safety fairway parallel to the coast; this fairway is more than 20 nautical miles north of the proposed Port. The only major cruise port in Louisiana is the Port of New Orleans, on the east side of the state. Cruise ships departing the Port of New Orleans chiefly head toward Mexico and destinations in the Caribbean; few, if any, would have reason to transit near the proposed Port.

3.7.7 Offshore Visual Resources

The existing visual character in the proposed Project vicinity is open ocean with oil and gas platforms, drilling rigs, and aids to navigation (floating channel marker buoys). The proposed pipeline bypass location and the proposed Port would not be visible from the closest location on shore, which is 24.7 nautical miles.

There are 50 oil and gas platforms located within a 20 nautical mile radius of the proposed Port. Two heavily trafficked shipping fairways are located on either side of the proposed Port. These fairways are the preferred routes for large commercial and industrial vessels heading to and from Gulf Coast ports. Examples of commercial and industrial vessels in operation in the proposed Project vicinity include container ships, bulk carriers, tankers, and occasionally ocean-going passenger vessels.

Recreational boaters would be the most sensitive visual receptor in the proposed Project vicinity; however, offshore oil and gas activity has been occurring in the Gulf of Mexico off the coast of Louisiana since 1947, and the Gulf of Mexico hosts seven of the top 10 industrial ports in the United States. It can be assumed that most recreational boaters in the proposed Project vicinity are accustomed to industrial platforms and vessels that punctuate the Gulf of Mexico.

3.8 Offshore Transportation

This section is limited to discussion of offshore transportation; onshore transportation and public services are discussed in the Socioeconomics Section 3.18.6.

3.8.1 Definition of the Resource

The Gulf of Mexico is heavily transited by cargo vessels, container ships, barges, and tankers carrying crude oil or other liquid commodities. The proposed Port would be located approximately 40 nautical miles from the coast of Cameron Parish, Louisiana, and would be well beyond the jurisdiction of regional vessel traffic control systems. The Gulf of Mexico, however, has a network of designated shipping safety fairways that are de facto marine highways for large commercial vessels. Defined in Title 33 CFR, shipping safety fairways and anchorage areas in the Gulf of Mexico “are established to control the erection of structures therein to provide safe approaches through oil fields in the Gulf of Mexico to entrances to the major ports along the Gulf Coast” (33 CFR 166.200).

3.8.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to offshore transportation (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- CZMA,
- Submerged Shelf Lands Act, and
- Outer Continental Shelf Lands Act.

3.8.3 Required Permits

No specific permits are applicable for offshore transportation.

3.8.4 Existing Threats

Commercial shipping vessels and private vessels impact transportation in the Gulf of Mexico, along with energy industry activity such as the movement of drill rigs, service boats and helicopters, derrick barges and pipeline construction barges. Also, the presence of marine mammals such as whales is an issue that must be considered when discussing transportation.

3.8.5 Existing Conditions

Existing conditions, including commercial boating, recreational boating, and commercial shipping traffic are discussed in the following subsections.

3.8.5.1 Commercial and Recreational Boating Traffic

The activities of recreational boating and fishing greatly overlap in the state of Louisiana. The majority of boat trips are taken for the purpose of recreational fishing (Isaacs and Lavergne 2010). In Louisiana, the recreational boating and fishing season is essentially year round, with seasonal peaks (Savoie 2014). Louisiana has a remarkably high proportion of boat registrations compared with its population. Among all states, it has the 15th highest number of boat registrations yet only the 25th highest population (Isaacs and Lavergne 2010). The number of boat registrations in the southwest parishes in 2010 was 36,002, or 11.5 percent of registrations statewide. Comprehensive recreational boating data for localized areas of Louisiana coastal waters is difficult to obtain, and most data are collected through self-reporting and periodic surveys. One detailed boating survey conducted by the LDWF collected responses from 1,298 boat owners in the state, including 151 responses from boat owners in southwest parishes (Isaacs and Lavergne 2010). Of the southwest boat owners who responded to the survey, 49.7 percent reported taking trips in saltwater, brackish ponds, or marsh in the previous year, and 8.5 percent took trips in the Gulf of Mexico or other offshore water body. Among them, the majority took trips for the purpose of recreational fishing (79.9 percent). The next highest boat activity was "recreational boating" (20.9 percent), followed by skiing and other water sports (19.6 percent). This trend followed the same general pattern in the state (Isaacs and Lavergne 2010). Recreational boaters intending to take trips off coastal Cameron Parish or in the Gulf waters offshore have a variety of launch points from which to choose. Cameron Parish currently has six public recreational boat launches located along interior bayous and the West Calcasieu Ship Channel that are maintained by the Cameron Parish Police Jury (Cameron Parish Police Jury 2015). In addition, boats launched from Calcasieu, Jefferson, and Vermilion parishes and from Jefferson County, Texas, provide boaters with close enough access to spend single day trips in waters offshore of Cameron Parish (Savoie 2014).

Table 3.8-1 shows the number of saltwater fishing trips aboard private, rental, and charter boats, for the years 2004 to 2013.

Table 3.8-1. Recreational Saltwater Fishing in Louisiana State Inland and Territorial Seas and the Exclusive Economic Zone (2004 to 2013)

Year	Trips in Inland Saltwater Bodies	Trips in State Territorial Waters (0 to 3 nm)	Trips in EEZ offshore of Louisiana (3 to 200 nm)	Total Saltwater Trips a/	Percent (%) Trips in EEZ of Total Trips
2004	3,636,117	179,300	149,115	4,143,832	3.6
2005	2,693,718	89,716	122,744	2,995,894	4.1
2006	2,695,145	142,170	150,914	3,130,399	4.8
2007	3,026,270	116,066	157,146	3,415,548	4.6
2008	3,456,374	108,265	122,664	3,795,568	3.2
2009	3,153,567	84,939	120,525	3,443,970	3.5
2010	3,052,034	62,109	19,674	3,195,926	0.6
2011	3,272,702	84,925	96,694	3,539,246	2.7
2012	2,776,983	120,499	108,330	3,126,311	3.5
2013	3,143,462	87,570	81,103	3,399,705	2.4

Note:
a/ Trips include trips by private/rental boats and charter boats. Statistics for party (head) boats were not maintained in the NOAA Fisheries dataset. Statistics do not include shore-based fishing.
Key: EEZ = Exclusive Economic Zone; nm = nautical mile
Source: NOAA Fisheries (2015t)

Sport fishing is an important activity in Gulf of Mexico waters and inland waterways. In the Gulf of Mexico, 7 percent of recreational fishing is conducted from charter boats and about 50 percent is done from private or rented boats. The remaining 43 percent of recreational fishing occurs onshore. As shown in Table 3.8-2, marine fishing is a prominent recreational activity in both Louisiana and Texas that brings a considerable number of tourists to the coast every year.

Table 3.8-2. Recreational Fishing Effort, Landings, and Releases in Louisiana and Texas from the Gulf of Mexico (2004 to 2013)

Year	State	Angler Trips	Total Landings a/ (lbs)	Total Released a/ (lbs)
2004	Louisiana	2,250,691	1,5848,474	22,961,884
	Texas	1,126,558	2,014,548	NA
2005	Louisiana	4,065,078	13,014,471	19,293,367
	Texas	1,061,479	1,847,949	NA
2006	Louisiana	3,763,274	16,273,961	21,488,328
	Texas	1,156,790	2,115,635	NA
2007	Louisiana	4,188,282	14,937,398	19,171,321
	Texas	1,057,814	1,821,398	NA
2008	Louisiana	4,620,056	18,234,349	22,770,494
	Texas	1,055,600	1,838,743	NA
2009	Louisiana	4,128,014	16,642,340	20,161,303
	Texas	1,041,027	1,806,913	NA
2010	Louisiana	3,862,487	13,776,038	18,370,898
	Texas	991,485	1,733,761	NA
2011	Louisiana	4,576,247	17,714,013	20,246,288
	Texas	1,125,401	2,483,184	NA
2012	Louisiana	4,136,564	15,293,294	20,033,417
	Texas	1,159,189	2,257,311	NA
2013	Louisiana	4,661,154	16,253,583	26,749,766
	Texas	1,149,597	2,009,146	NA

Note:
a/ All species combined.
Key: NA = Not Available
Source: NOAA Fisheries (2015u)

3.8.5.2 Commercial Shipping Traffic

Seven of the top 10 commercial ports in the United States by cargo tonnage are located along the Gulf Coast (USACE 2015). Designated shipping safety fairways that are de facto marine highways for large commercial vessels are nearby the proposed Port. The Sabine Pass Safety Fairway is the closest to the nearest TYMS at only 3.1 nautical miles to the southwest of the proposed Port, and the Calcasieu Pass Safety Fairway is approximately 13.5 nautical miles to the east of the proposed Port.

The Sabine Pass Safety Fairway leads into the Sabine-Neches Waterway (SNWW), home of the ports of Port Arthur, Beaumont, and Orange that delineate the region locally known as the "Golden Triangle" (USACE 2010b). The waterway ranks first in the United States for crude oil imports, and is host to four large oil refineries, two LNG import terminals, and two pipeline terminals that supply 54.6 percent of the nation's strategic petroleum reserves. The Port of Beaumont, the largest of the three ports, is also the country's largest military outload port, also called a Sea Port of Embarkation.

Vessel Traffic Services (VTS) Port Arthur, a department of the USCG Marine Safety Unit, actively monitors and coordinates vessel traffic in and around the SNWW to prevent collisions, groundings, and damage to the property and the environment. VTS Port Arthur monitors "all waters of the Sabine-Neches Waterway to Port Arthur, Beaumont, and, including the offshore fairway [from the SNWW] to the sea buoy, the east/west crossing offshore fairway extending 12 miles on either side of the main channel, and the Gulf Intracoastal Waterway from mile 260 to mile 295" (USCG 2014). The channels leading to the ports of Port Arthur and Beaumont are both authorized to 40-ft depths.

Table 3.8-3 lists Gulf Coast ports in the region that were ranked among the top 150 ports in the United States by cargo tonnage in 2013. Of the ranked ports along the SNWW, the Port of Beaumont, Port Arthur, and Port of Orange ranked 4th, 18th, and 150th, respectively (USACE 2015). Among Gulf of Mexico ports, the Port of Beaumont, Port Arthur, and Port of Orange ranked 3rd, 11th, and 33rd, respectively.

Table 3.8-3. Nearby Gulf of Mexico Ports Ranked Among the Top 150 U.S. Ports by Cargo Tonnage

US Rank	Gulf of Mexico Rank	Port Name (State)	Shipping Safety Fairway	Total Cargo 2013 (short tons)	Cargo Percent Change from 2012
2	2	Houston (TX)	Galveston Entrance	229,246,833	-3.8
4	3	Beaumont (TX)	Sabine Pass	94,403,631	20.2
11	8	Lake Charles (LA)	Calcasieu Pass	56,577,328	4.0
13	10	Texas City (TX)	Galveston Entrance	49,674,036	-12.4
18	11	Port Arthur (TX)	Sabine Pass	34,699,150	13.3
49	16	Galveston (TX)	Galveston Entrance	11,406,750	-1.8
150	33	Orange (TX)	Sabine Pass	758,969	NA

Key:
LA = Louisiana; NA = Not Available; TX = Texas
Source: USACE (2015)

3.8.5.3 Existing Traffic Lanes and Navigation

Figure 3.8-1 is a commercial vessel transit density map consisting of trips made by major commercial vessels in the one-year period in 2013 (January-December) in the vicinity of the Gulf of Mexico near the proposed Project.

As seen in the figure, the majority of offshore commercial vessel transits occur within the established shipping safety fairways. It should be noted that transit data only represent commercial vessels equipped with AIS at the time the data were collected.[21] Two major shipping safety fairways pass within approximately 13.5 nautical miles (25.0 km) of the proposed Port, specifically the Sabine Pass and Calcasieu Pass safety fairways. The two fairways are connected by the Sabine Calcasieu Safety Fairway that runs east to west and parallel to the coast. No other designated navigation zones (e.g., ATBAs, precautionary areas, or separation zones) are located near the proposed Port. Major commercial vessels are not required to transit within the shipping safety fairways, but the majority of large vessels equipped with AIS use the lanes voluntarily.

[21] 33 U.S.C. 164.46.

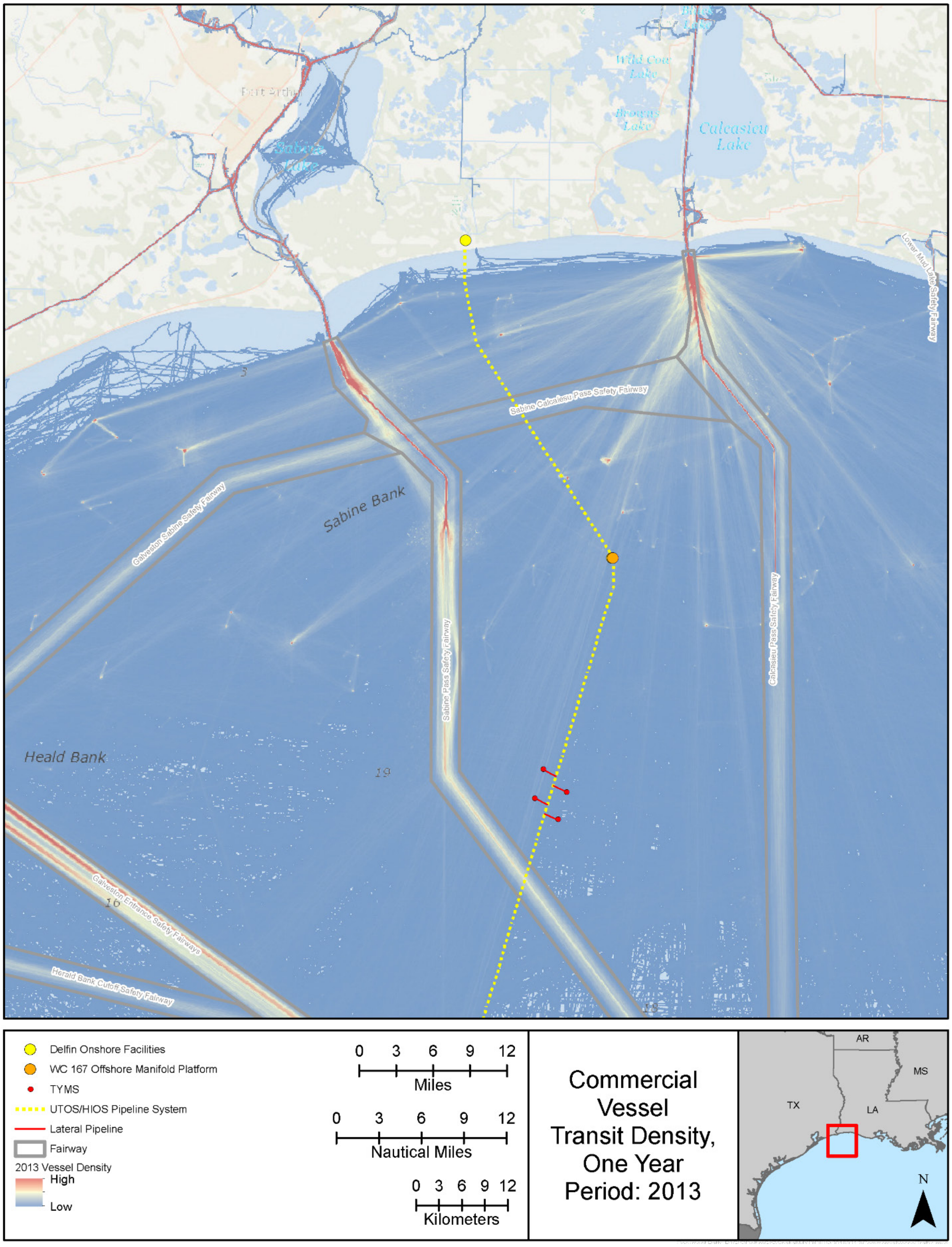


Figure 3.8-1. Commercial Vessel Transit Density, One-Year Period: 2013

3.9 Offshore Air Quality

This section is limited to discussion of offshore air quality; onshore air quality is addressed in Section 3.16.

3.9.1 Definition of the Resource

In this document, air quality is defined as a measurement of pollutants in ambient air. Air quality as described here may be affected by proposed Project construction, operation, and decommissioning. Carbon dioxide, sulfur dioxide, ozone, particulate matter, and heavy metal emissions are some of the potential hazards that can negatively impact air quality. Degradation of air quality can negatively impact human health and wildlife. Also, emissions can potentially contribute to climate change.

3.9.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to offshore air quality (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- Clean Air Act, including:
  - National Ambient Air Quality Standards (NAAQS),
  - Air quality control regions (AQCRs),
  - New Source Performance Standards (NSPS),
  - National Emission Standards for Hazardous Air Pollutants (NESHAP), and
  - General Conformity;
- Louisiana Ambient Air Quality Standards (LAAQS); and
- Louisiana Emission Standards and Requirements.

3.9.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- Prevention of Significant Deterioration (PSD) Permit, and
- Title V Operating Permit.

3.9.4 Existing Threats

Existing threats in and near the proposed Project area include energy industry facilities and boat traffic. Drilling platforms, drill rigs, derrick barges, and pipeline construction barges all contribute to emissions, negatively impacting air quality. Commercial and private vessels are also sources of emissions which may negatively impact air quality.

3.9.5 Existing Conditions

Existing conditions, including offshore regional climate, existing ambient air quality, and greenhouse gasses and climate change are discussed in the following subsections.

3.9.5.1 Regional Climate

The location for the proposed Port is in the Gulf of Mexico, approximately 37.4 to 40.8 nautical miles from the shoreline of southwest Louisiana. Although descriptions of regional climate do not typically include areas of open water, the nearest coastal climate can be described.

All of Louisiana can be classified as having a warm, humid climate with hot summers (Köppen-Geiger climate classification Cfa) (NOAA 2016). Historic data from Lake Charles Regional Airport, which is near the proposed DOF, indicate a mean daily temperature ranging from 83°F in August to 51.8°F in January, with mean daily highs ranging up to 91.9°F in August, and mean daily lows ranging down to 42.3°F in

January. Mean annual precipitation is 57.5 inches, distributed relatively evenly throughout the year (Southern Regional Climate Center 2016).

The entire Gulf of Mexico and its coastal areas are subject to tropical storms and hurricanes, which are most likely to occur between late May and early November. On average, the proposed Project area will experience a tropical storm (sustained winds of at least 39 miles per hour, or 17 m/s) every 1 or 2 years, while a hurricane (sustained winds of at least 74 miles per hour, or 33 m/s) can be expected to cross the proposed Project area once every 4 to 5 years. A "major" hurricane rated as Category 3 or higher (sustained winds of at least 110 miles per hour, or 50 m/s) may occur about once every 25 years. At the proposed Port location, storms have the potential to produce significant waves that present a hazard to ocean-going vessels. Along coastal locations, heavy rains and wind-driven storm surges may cause local or widespread flooding.

3.9.5.2 Existing Ambient Air Quality

NAAQS were developed by the USEPA to protect public health (primary standards) and public welfare (secondary standards). Primary standards are based on observable human health responses and are set at levels that provide an adequate margin of safety for sensitive segments of the population. Secondary standards are intended to protect welfare interests such as structures, vegetation, and livestock. Air dispersion modeling is used by proposed new sources to demonstrate compliance with both the primary or secondary standards. States use ambient air monitoring systems to determine whether AQCRs are meeting the NAAQS. Areas meeting the NAAQS are termed attainment areas, and areas not meeting the NAAQS are termed nonattainment areas. Areas that have insufficient data to make a determination of attainment/nonattainment are unclassified or are not designated, but are treated as being attainment areas for permitting purposes. The designation of an area is made on a pollutant-specific basis.

For offshore locations beyond the seaward state territorial boundary, no status has been designated with respect to the NAAQS. Therefore, the NAAQS attainment status of the nearest adjacent onshore location should be considered. Cameron Parish, Louisiana, which is the nearest onshore location to the proposed Port, is designated as attainment for all NAAQS. In addition, the nearest onshore location in Texas, located in Jefferson County, has also been designated as attainment for all NAAQS.

As a conservative representation of existing ambient air quality at the proposed Delfin Port location, Table 3.9-1 presents monitoring data from the nearest onshore monitoring sites, located in Calcasieu Parish, Louisiana, and in Beaumont/Port Arthur Texas. The monitoring values shown are for the 3-year period of 2011 through 2013. The existing background concentrations at the proposed Port location are likely to be lower than the values shown, due to the scarcity of nearby emission sources relative to the onshore monitoring sites.

Table 3.9-1. Background Ambient Air Quality and Ambient Air Quality Standards

Air Pollutant	Averaging Period	Statistic	Monitor Values a/	Monitoring Site (Site ID)	Primary NAAQS b/
Sulfur Dioxide (SO_2)	1-hour	99th Percentile of daily 1-hour maximum averaged over 3 years	37 ppb	Westlake, LA (220190008)	75 ppb
Carbon Monoxide (CO)	1-hour	Not to be exceeded more than once per year	0.7 ppm	Jefferson Co., TX (482451035)	35 ppm
	8-hour		0.5 ppm	Jefferson Co. TX (482451035)	9 ppm
Nitrogen Dioxide (NO_2)	1-hour	98th percentile averaged over 3 years	30 ppb	Westlake, LA (220190008)	100 ppb
	Annual	Annual mean	16 ppb	Westlake, LA (220190008)	53 ppb

Table 3.9-1. Background Ambient Air Quality and Ambient Air Quality Standards (continued)

Air Pollutant	Averaging Period	Statistic	Monitor Values a/	Monitoring Site (Site ID)	Primary NAAQS b/
Ozone (O_3)	8-hour	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years	67 ppb	Westlake, LA (220190008)	70 ppb
Particulate Matter (PM_{10})	24-hour	Not to be exceeded more than once per year on average over 3 years	74 μg/m^3 c/	Lafayette, LA (220550007)	150 μg/m^3
Particulate Matter ($PM_{2.5}$)	24-hour	98th percentile averaged over 3 years	19 μg/m^3	Lake Charles, LA (220190010)	35 μg/m^3
	Annual	Annual mean averaged over 3 years	8.4 μg/m^3	Lake Charles, LA (220190010)	12 μg/m^3
Lead (Pb)	Rolling 3-month	Not to be exceeded	d/	–	0.15 μg/m^3

Notes:

a/ Monitor value shown matches the statistic of the NAAQS. Three-year averages are formed from 2011 to 2013 data. For CO, value shown is maximum second highest occurring in the 2011 to 2013 period. For NO2 annual, value shown is highest annual mean from the period 2011 to 2013.

b/ Secondary standards are promulgated for some pollutants and are generally the same as or less stringent than primary standards. The revised ozone NAAQS (70 ppb) was signed by the USEPA Administrator on October 1, 2015 and will be effective 60 days after publication of the final rule in the Federal Register. Publication date is unknown at this time.

c/ Value shown is maximum 2nd high from 2010 to 2012 data. Monitoring for PM10 24-hour is not performed in south-western Louisiana. Closest monitoring site is Lafayette, Louisiana.

d/ Monitoring for lead is not performed in south-western Louisiana. Closest historical monitoring site is in Beaumont, Texas. Historical data at that location have shown compliance with the NAAQS.

Key:

ppb = part per billion; ppm = part per million; μg/m^3 = microgram per cubic meter

3.9.5.3 Greenhouse Gases and Climate Change

Solar radiation is primarily responsible for the Earth's climate system. Earth's temperature has been relatively constant over many centuries. Therefore, the incoming solar energy has been nearly in balance with outgoing radiation. Of the incoming solar shortwave radiation, about half is absorbed by the Earth's surface. The fraction of this radiation reflected back to space by gases and aerosols, clouds and by the Earth's surface is approximately 30 percent, and about 20 percent is absorbed in the atmosphere. Based on the temperature of the Earth's surface the majority of the outgoing energy flux from the Earth is in the infrared part of the spectrum. The longwave radiation (also referred to as infrared radiation) emitted from the Earth's surface is largely absorbed by certain atmospheric constituents—water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O) and other greenhouse gases (GHGs). The downward directed component of this longwave radiation adds heat to the lower layers of the atmosphere and to the Earth's surface. This is the known as the greenhouse effect.

The most important GHGs globally are CO_2, CH_4, and N_2O and these are the key GHGs potentially emitted by as well as potentially offset by the proposed Port. The increase in GHGs in the atmosphere from human-made or anthropogenic sources since the beginning of industrialization correlates with an increase in global average temperature.

The increasing trend in GHG concentrations and the potential effect of this change in atmospheric GHG concentrations on global climate has been studied extensively and is reported by the Intergovernmental Panel on Climate Change (IPCC). The IPCC was set up in 1988 by the World Meteorological Organization and the United Nations Environment Programme to provide governments with a view of the state of knowledge about the science of climate change, potential impacts, and options for adaptation and mitigation through assessments of the most recent information published in the scientific, technical and socio-economic literature worldwide. The IPCC has released a series of reports over the past 15 years, with the latest being the Fifth Assessment Report (IPCC 2013). While the first IPCC assessment depended primarily on observed changes in surface temperature and climate model analyses, more recent assessments include multiple lines of evidence for climate change. The Fifth Assessment Report states,

> *there is incontrovertible evidence from in situ observations and ice core records that the atmospheric concentrations of GHGs such as CO_2, CH_4, and N_2O have increased substantially over the last 200 years. In addition, instrumental observations show that land and sea surface temperatures have increased over the last 100 years. Satellites allow a much broader spatial distribution of measurements, especially over the last 30 years. For the upper ocean temperature the observations indicate that the temperature has increased since at least 1950. Observations from satellites and in situ measurements suggest reductions in glaciers, Arctic sea ice and ice sheets. In addition, analyses based on measurements of the radiative budget and ocean heat content suggest a small imbalance. These observations, all published in peer-reviewed journals, made by diverse measurement groups in multiple countries using different technologies, investigating various climate-relevant types of data, uncertainties and processes, offer a wide range of evidence on the broad extent of the changing climate throughout our planet.*

Climate change is a global issue with all regions contributing anthropogenic GHG emissions and being impacted by climate change to various degrees. The IPCC has reported that a wide range of environmental effects could result from increasing concentrations of GHGs in the atmosphere. These may include increases in sea level and changes in weather patterns resulting in changes in temperature and moisture availability on a regional basis. These weather changes can then cascade to changes in biological communities both on land and in the ocean.

Locally, the Southern Climate Impacts Planning Program reports that the following impacts of climate change have already been observed in Louisiana (SCIPP 2014):

- Increasing temperatures have resulted in more frequent long-lasting heat waves, and since 1970, there are on average 10 to 20 fewer freezing days per year in Louisiana, encouraging the spread of mosquito-borne illnesses.
- Due to a combination of land subsidence and sea level rise, Louisiana has lost 1,900 square miles of coastal land in the past century.
- Also due to subsidence, sea level rise in the past century has been higher than the global average along Louisiana's coast, with Grand Isle experiencing 36 inches of sea level rise, versus a global average of 8 inches.
- Average annual precipitation in the region has increased by 20 to 30 percent in the past century, and a higher proportion of total rainfall is occurring during intense storms, increasing the likelihood of flash flooding.

GHG Regulations

The proposed Port would be a major source for emissions of criteria pollutants, and would be required to apply for and receive a PSD air permit from USEPA. As a major PSD source, the proposed Port must therefore apply Best Available Control Technology (BACT) to its potential GHG emissions. Delfin LNG has included a GHG BACT analysis in its draft PSD air permit application. This analysis evaluates GHG control technologies for combustion emissions of CO_2, as well as for fugitive GHG emissions (primarily methane) from facility piping components.

The proposed Port would also be subject to GHG reporting requirements under 40 CFR 98, which apply to owners and operators of certain facilities emitting greater than 25,000 metric tons per year of carbon dioxide equivalent emissions (CO_2e). The proposed Port would be included in the petroleum and natural gas systems category specified in 40 CFR 98, Subpart W. CO_2e emissions are calculated by multiplying total mass emissions for each individual GHG by its global warming potential (GWP), and then adding the results. For example, methane and N_2O, which after CO_2 are the two most common GHGs emitted by a facility of this type, have GWP factors of 25 times and 298 times that of CO_2, respectively.

3.10 Offshore Noise

This section is limited to discussion of offshore noise resources; onshore noise resources are addressed in Section 3.17.

3.10.1 Definition of the Resource

Sound travels through the water as vibrations of the fluid particles in a series of pressure waves. The waves comprise a series of alternating compressions (positive pressure variations) and rarefactions (negative pressure fluctuations). Because sound consists of variations in pressure, the unit for measuring sound is usually referenced to a unit of pressure, the Pascal (Pa). The unit usually used to describe sound is the decibel (dB) and, in the case of underwater sound, the reference unit is taken as 1 microPascal (µPa), whereas airborne sound is usually referenced to a pressure of 20 µPa. To convert from a sound pressure level referenced to 20 µPa to one referenced to 1 µPa, a factor of 20 log (20/1), i.e., 26 dB has to be added to the former quantity. Table 3.10-1 provides a comparison of in-air to underwater sound levels.

Table 3.10-1. A-Weighted Sound Levels for Some Common Airborne Sounds A-Weighted Level (dBA)

re 20 µPa	re 1 µPa	Source of Sound a/
110-120	136-146	Rock-n-roll band
100-110	126-136	Jet flyby at an altitude of 1,000 feet
90-100	116-126	Power mower b/
80-90	106-116	Heavy truck at 40 miles/hour at 49 feet; blender b/
70-80	96-106	Car at 62 miles/hour at 25 feet; clothes washer b/
60-70	86-96	Ocean surf; vacuum cleaner; air conditioner at 20 feet b/
50-60	76-86	Light traffic at 98 feet
40-50	66-76	Ocean offshore; quiet residential area – daytime
30-40	56-66	Quite residential area – nighttime
20-30	46-56	Wilderness area

Notes:
a/ Source: Richardson et al. (1995)
b/ Measured at operator's position.

There are several descriptors used to characterize a sound wave. The difference between the lowest pressure variation (rarefaction) and the highest pressure variation (compression) is the peak to peak (or pk-pk) sound pressure level. The difference between the highest variation (either positive or negative) and the mean pressure is called the peak pressure level. Lastly, the root mean square (rms) sound pressure level is used as a description of the average amplitude of the variations in pressure over a specific time window. These descriptions are show graphically in Figure 3.10-1.

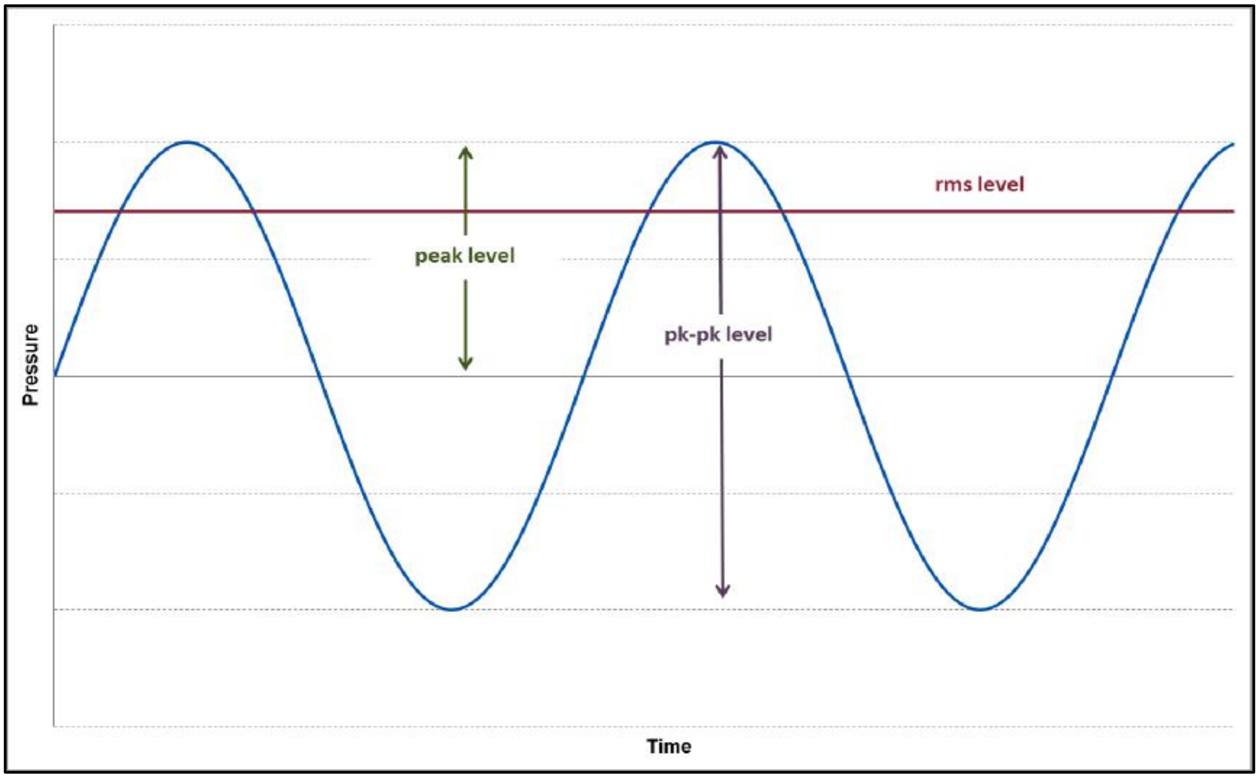


Figure 3.10-1. Underwater Sound Descriptors

Another useful measure of sound used in underwater acoustics is the sound exposure level (SEL). This descriptor is used as a measure of the total sound energy of an event or a number of events (e.g., over the course of a day) and is normalized to one second. This allows the total acoustic energy contained in events lasting a different amount of time to be compared on a like-for-like basis. Historically, use was primarily made of rms and peak sound pressure level metrics for assessing the potential effects of sound on marine life. However, the SEL is increasingly being used as it allows exposure duration and the effect of exposure to multiple events to be taken into account.

3.10.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to proposed Project noise (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- ESA, and
- MMPA.

3.10.3 Required Permits

No specific Federal or State permits regarding noise are required; however, Federal agencies must consult with the Secretary of Commerce on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect protected species, and the following authorizations must be obtained:

- NOAA Incidental Harassment Authorization, and
- NOAA Incidental Take Statement.

3.10.4 Existing Threats

Anthropogenic and natural sources both contribute to noise in the Gulf of Mexico. Bird calls and wind are the dominating natural noise sources. Ships are the most significant source of noise generated by human activity. Offshore energy industry operations also contribute to the Gulf's acoustic environment. Service vessels and helicopters, drilling rigs, derrick barges, and pipeline construction barges are all significant noise sources. These sources can impact marine life, some of which are protected by the ESA and all of which are protected by the MMPA, which prohibits the intentional harassment of marine mammals. The most relevant laws that need to be considered when assessing the impacts of underwater sound on marine mammals are the MMPA and the *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* recently revised by NOAA Fisheries (2016b). These criteria, as well as guidance related to sea turtles, is described in the following subsections.

3.10.4.1 Underwater Noise Regulatory Criteria

Underwater noise associated with the proposed Project is assessed against criteria derived from U.S. policy and recent guidance concerning marine fauna hearing. Criteria are provided by NOAA Fisheries in the MMPA, which gives Level A and B harassment criteria. Level A harassment is defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild. Level B harassment is defined as any act of pursuit, torment or annoyance that 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. Criteria are further separated for continuous and impulsive sounds.

NOAA Fisheries previously defined the zone of injury as the range of received levels from 180 linear decibels (dBL) rms referenced to 1 µPa (180 dBL re 1 µPa) as Level A Harassment, for instantaneous sound pressure levels at a given receiver location. This approach was designed to protect all marine species from high sound pressure levels at any discrete frequency across the entire frequency spectrum. It was a very conservative criterion, as it does not consider species-specific hearing capabilities. In 2016, NOAA released the *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals*. These guidelines provided a new definition of Level A Harassment. NOAA Fisheries continues to consider the threshold level for Level B harassment at 160 dBL re 1 µPa for impulsive sound and 120 dB for continuous sound, averaged over the duration of the signal. NOAA Fisheries will be developing updated acoustic thresholds for the onset of behavioral effects. Table 3.10-2 summarizes the MMPA Level A and B harassment criteria.

Table 3.10-2. Summary of NOAA Fisheries MMPA Criteria

	Criteria Level a/	Type
Level A Harassment	Varies by Species	Absolute
Level B Harassment	160 dBL re 1 µPa rms 120 dBL re 1 µPa rms	Impulse Continuous
Note: a/ Federal Register 70 Number 7		

3.10.4.2 NOAA Fisheries Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals

NOAA Fisheries released its *Technical Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammal Hearing* (2016b) to assess the potential impacts of underwater sound sources on species-specific marine mammals. In the Technical Guidance, NOAA Fisheries equates the onset of permanent threshold shift (PTS) with "harm" as defined in the ESA, and with "Level A Harassment" as defined in the MMPA. As such, PTS is considered equivalent to these two types of takes. NOAA equates temporary threshold shift (TTS) as "harassment" as defined under the ESA and "Level B Harassment" as defined in the MMPA. It is worth noting that NOAA also considers behavioral changes to constitute "harassment" and "Level B Harassment"; however, objective criteria for assessing behavioral change in marine mammals have not been updated. PTS refers to a permanent increase in the threshold of audibility for an ear at a specified frequency above a previously established reference level, whereas a TTS is a temporary change in hearing sensitivity that is non-injurious and reversible.

The Guidance assigns species of cetaceans and pinnipeds to functional hearing groups based on their hearing characteristics by Southall et al. (2007). Each functional hearing group has been assigned an M-weighting function to account for the fact that marine mammals do not hear equally well at all frequencies within their functional hearing range. M-weighting functions de-emphasize frequencies that are near the lower and upper frequency end of the estimated hearing range, where noise levels have to be higher to result in the same auditory effect (Southall et al. 2007). The M-weighting functions are similar in intent to the C-weighting function that is commonly used when assessing the impact of high-amplitude sounds on humans.

The recent Guidance also suggests revision to the M-weighting functions and functional hearing groups to account for new research findings; both expanding the upper hearing range of low frequency cetaceans, and splitting pinnipeds into two families. Table 3.10-3 presents the estimated auditory bandwidth and species applicable to the associated functional hearing group.

Table 3.10-3. Marine Mammal Functional Hearing Groups from NOAA Fisheries Guidance

Functional Hearing Group	Estimated Auditory Bandwidth	Relevant Species
Low-Frequency Cetaceans	7 hertz (Hz) to 35 kilohertz (kHz)	Baleen Whales
Mid-Frequency Cetaceans	150 Hz to 160 kHz	Dolphins, Sperm Whales
High-Frequency Cetaceans	275 Hz to 160 kHz	Harbor Porpoise
Phocid Pinnipeds	50 to 86 kHz	Seals
Source: NOAA Fisheries (2016b)		

NOAA Fisheries' Guidance prescribes the applicable criteria for assessing underwater noise impacts on marine mammals. The Guidance proposes dual criteria, utilizing both peak sound pressure in dB (dBpeak) and cumulative sound exposure level (cSEL) metrics, with assessment to be based upon whichever criterion is exceeded first. Both M-weighted and unweighted SEL criteria are provided; however, NOAA notes that the unweighted SEL criteria are likely to result in an overly conservative assessment, as they do not take into account the hearing sensitivity of the receiver functional hearing group. Table 3.10-4 outlines the criteria from the Guidance, which have been adopted for this assessment, including the proposed PTS and TTS cSEL criteria for marine mammals.

Table 3.10-4. Proposed PTS and TTS SEL Criteria for Marine Mammals

Hearing Group	PTS onset (dBpeak re 1 μPa)	PTS onset (dB re 1 μPa^2 s)		TTS onset (dB re 1 μPa^2 s)
	Impulsive	Impulsive	Non-impulsive	Non-impulsive
Low frequency cetaceans	219	183	199	179
Mid-frequency cetaceans	230	185	198	178
High frequency cetaceans	202	155	173	153
Phocid pinnipeds (underwater)	218	185	201	181
Otariid Pinnipeds (underwater)	232	203	219	199
Source: NOAA Fisheries (2016b)				

Sound is a critical component in the natural history of marine mammals. Each species makes use of sound in different ways to forage, orient, socially interact with other conspecifics (including for reproduction), to detect or respond to predators, and in other behaviors. Odontocetes, or toothed mammals such as dolphins and killer whales, produce broad-spectrum clicks and whistles that can range between 1 and 200 kilohertz (kHz) (NRC 2003a). Mysticetes, or baleen whales, generally have lower frequency calls, ranging between 0.2 and 10 kHz (NRC 2003a). Odontocetes (e.g., dolphins) use sound for many reasons. One major purpose is to forage, by using echolocation to find fish. They produce short ultrasonic clicks that result in echoes that form an acoustic image to help them detect food, obstacles, etc. Mysticetes use sound to navigate and communicate with other conspecifics.

Noise is of particular concern to marine mammals because of the critical part sound plays for many marine mammal species. It is their primary sense for navigating, finding prey, avoiding predators, and communicating with other con-specific individuals. Marine mammals may have varying reactions to noise. Noise disturbances may cause marine mammals to leave a habitat, impair their ability to communicate, or cause stress (Hildebrand 2005; Tyack et al. 2011; Rolland et al. 2012; Erbe et al. 2012). Noise can cause behavioral changes, mask other sounds including their own vocalizations, may result in injury, and in some cases, may directly injure or kill or result in behaviors that ultimately lead to death (NRC 2003a; Nowacek et al. 2007; Southall et al. 2009; Tyack 2009). The sound frequency range within which whales communicate and echolocate overlaps to the frequency ranges of much ship noise (Veirs et al. 2016; Richardson et al. 1995). Increasing ship traffic affects the ability of whales and dolphins to communicate, search for prey, and avoid predators. Over the past decades, commercial shipping has become more prevalent, which in turn has led to an overall increase in underwater noise (Wright 2008).

Increase ship noise may mask marine mammal communications. Masking occurs at almost all frequencies in the range of marine mammal use (Hildebrand 2005; Weilgart 2007). Masking is the reduction in an animal's ability to detect sounds due in the presence of other sounds (in this context, from anthropogenic sounds) that block natural sounds. Studies for example on killer whales have found that chronic exposure to boat traffic and noise can cause whales to reduce their time spent feeding (Williams et al. 2006). Studies of bottlenose dolphins (*Tursiops runcates*) have reported changes in vocalization rates when exposed to boat noise (Buckstaff 2004).

Stress-related responses from increased ambient and local noise levels can include rapid swimming away from ship[s] for distances up to 80 km; changes in surfacing, breathing, and diving patterns; changes in group composition; and changes in vocalizations (NRC 2003a; Richardson et al. 1995). Stress due to noise can lead to long-term health problems, and may pose increased health risks for populations by weakening the immune system and potentially affecting fertility, growth rates and mortality (Romano et al. 2004). Louder anthropogenic sounds may also lead to TTS or PTS, which in turn could interfere with foraging efforts or increase vulnerability to predators.

It has been predicted that noise impacts on marine mammals may increase with global climate change since the absorption of carbon dioxide by the ocean could create noisier oceans (Hester et al. 2008). When greenhouse gas reacts in the ocean, it lowers pH, creating more acidic waters. The more acidic the water, the less that sound waves are absorbed and this ocean acidification is likely to reduce the ability of surface seawater to absorb sound at frequencies important to marine mammals. A louder ocean would negatively affect cetaceans that rely on sound to navigate, communicate, find food, and avoid predators.

Most observations of behavioral responses of marine mammals to human-generated sounds have been limited to short-term behavioral responses, which include generally short term disturbances to feeding, resting, or social interactions. Responses such as rapid diving, change in swim speed, or change in respiration rate can add stress on young animals, though overall these are considered minor short term, not biological significant impacts. If noise causes an animal to leave an area especially on a permanent basis that is a more adverse impact. Responses to noise also include changes in the type or timing of marine mammal vocalizations relative to the source of the sound, and/or masking of sounds from other individuals of the same species. Some species have been shown to respond negatively by retreating or by engaging in antagonistic responses (Watkins 1986; Terhune and Verboom 1999).

Southall et al. (2007) reported bottlenose dolphins produce sounds in the frequency range of 100 hertz (Hz) to 35 kHz at a source Level (dB re 1 µPa at 1 m) of 137 to 236 dB and are considered able to hear sounds between 150 Hz to 160 kHz. In general, Odontocetes (including mid-frequency cetaceans such as the bottlenose) produce sounds across the widest band of frequencies, with audiograms having a general U-shape and a functional hearing range between approximately 150 Hz and 160 kHz. Their social vocalizations range from a few hundreds of Hz to tens of kHz (Southall et al. 2007). They also generate specialized echolocation clicks at frequencies above 100 kHz that are used to detect, localize, and characterize underwater objects such as prey. Echolocation clicks have source levels that can be as high as 229 dB re 1 µPa (Au et al. 1974) and are the highest source levels of any marine mammal sounds.

3.10.4.3 Noise Exposure Criteria for Sea Turtles and Fish

Sound exposure guidelines for fishes and sea turtles were recently developed within a technical report by the ANSI-accredited Standards Committee and are applicable to the proposed Project (Popper et al. 2014). Little is known about how sea turtles make use of sound in both terrestrial and underwater environments. There are no published underwater noise criteria for turtles in U.S. waters. Young (1991), cited in Keevin and Hempen (1997), provides an empirical safety range equation for underwater explosions from military activities for a variety of marine fauna, including turtles. The safety range was based on Gulf of Mexico oil platform criteria established by the NOAA Fisheries. Keevin and Hempen (1997) also provide details of two cases where physical injury was reported in turtles unintentionally exposed to underwater explosions, with details of the charge weight and approximate distance the injured turtle was from the blast. Substituting the values from these cases into the equations from Young (1991) gives an equivalent peak noise safety level for turtles of 222 dBpeak re 1 µPa. Behavioral criterion is derived from McCauley et al. (2000) who conducted tests on green and loggerhead turtles that showed increased swimming behavior when exposed to noise from air guns between levels of 166 and 75 dB rms re 1 µPa (Table 3.10-5). More conservative sea turtle underwater acoustic injury and behavioral thresholds of 207 dB re 1 µPa and 166 dB re 1 µPa, respectively (Table 4.3-8), have been used in NOAA Fisheries Biological Opinions (NOAA Fisheries 2015v) and are applied in these analyses. No distinction is made between impulsive and continuous sources for these thresholds.

Table 3.10-5. Underwater Noise Criteria for Sea Turtles

Hearing Group	Non-auditory or Auditory Injury (dBpeak re 1 µPa)	Behavioral Response (dB rms re 1 µPa)
	(Harm)	(Harassment)
Sea turtles	207	166

The guidelines provided in Popper et al. (2014) are presented for different categories of sources including explosions, pile driving, seismic airguns, naval sonar, and shipping and other continuous noise sources. In addition, the effects of sound exposure were placed into five categories such as mortality and potential mortal injury, recoverable injury, TTS, masking and behavioral effects. Of most relevance to the proposed Project are those guidelines pertaining to pile driving and shipping and other continuous noise sources. Guidelines are given in terms of dual criteria; single strike peak sound pressure level (dBpeak re 1 µPa) and the cumulative SEL (dB re 1 µPa^{2}s cSEL). For pile driving, guidelines are only provided for mortality and potential mortal injury, which are prescribed as 210 dB re 1 µPa^{2}s cSEL or 207 dBpeak re 1 µPa. Data applicable to sea turtle exposure to shipping and/or other continuous noise sources were unavailable. These sound exposure guidelines are based on the best scientific data and are to be treated as interim until further research allows refinement and completion.

The Fisheries Hydroacoustic Working Group (FHWG) was formed in 2004 and consists of biologists from NOAA Fisheries, USFWS, Federal Highway Administration, and the California, Washington and Oregon Departments of Transportation, supported by national experts on sound propagation activities that affect fish and wildlife species of concern. In November 2015, the agencies updated their technical guidance on the hydroacoustic effects on ESA-listed fish species. These criteria include injury levels for fish at or above 2 grams and smaller than 2 grams (see Table 3.10-6). The report mentions that agencies have used 150 dB rms as a threshold for behavioral disturbance for ESA-listed fish species, but neither NOAA Fisheries nor USFWS has provided any research data or related citations to support this threshold. For shipping activities, Popper et al. (2014) suggest a high risk of behavioral response for fish with tens of meters, a moderate risk at the hundreds of meters range and a low risk at thousands of meters. Fish that involve their swim bladder in hearing are more likely to experience disturbances at lower levels.

Table 3.10-6. Underwater Pile Driving Noise Criteria for Fish

Hearing Group	Injury Criteria (dBpeak re 1 μPa)	Injury Criteria (cSEL)	Behavioral (dB RMS re 1 μPa)
Fish (≥ 2 grams)	206	187	150
Fish (< 2 grams)	206	183	150

3.10.5 Existing Conditions

Existing ambient noise conditions in the Gulf of Mexico are the result of naturally occurring sounds and sounds from anthropogenic sources (noise generated by human activities). Examples of naturally occurring sound include wind, wave action, storms, earth movements, etc. as well as sounds created by marine wildlife. Sound level pressures in water from vocalizations of some baleen whales and dolphins can range from 170 dB to 228 dB re 1 µPa at 3.3 ft (1 meter) (Cummings and Thompson 1971; Thompson et al. 1986). Examples of anthropogenic noise include commercial shipping, oil and gas exploration and production activities (e.g., airguns, thrusters), commercial and recreational fishing (including fishing finding sonar, fathometers, and acoustic deterrent and harassment devices), recreational boating and whale watching activities, offshore power generation, research (including sound from sonar and telemetry), and military training and testing activities. Vessel noise in particular is a large contributor to noise in the marine environment and intensively used inland waters. Commercial shipping's contribution to ambient noise in the ocean has increased by as much as 12 dB over the last few decades (McDonald et al. 2008; Hildebrand 2005).

Vessel noise on this Project would be continuous, but would vary spatially depending on if the support vessel is in transit or moored at the proposed Port facilities. The intensity and frequency of the noise emissions are highly variable, both between and among these sources. However, there are typically long periods of low noise levels between the presence of service vessels and helicopter traffic at a specific location. Support and other vessels transmit noise through both air and water. The primary sources of vessel noise are propeller cavitation, propeller singing, and propulsion. A main source of ship noise is propeller cavitation (the sound poorly designed or old propellers make as they spin through the water (Cox 2014). Cavitation accounts for much of the human caused noise in the world's oceans. Cavitation may also increase due to hull designs that create non-homogenous wake fields behind ships. Even well-designed propellers and hulls may begin to cavitate if they are not regularly cleaned and smoothed (IMO 2014). Other sources include auxiliaries, flow noise from water dragging along the hull, and bubbles breaking in the wake. Propeller cavitation is usually the dominant underwater noise source. The intensity of underwater noise from vessels is roughly related to ship age, size, load size, and speed, with large ships being noisier than small ones, and ships underway with a full load (or towing or pushing a load) producing more noise than unladen vessels. Also, ship noise increases at higher speeds, as this increases the degree and volume of cavitation and onboard machine sounds. Another significant source of anthropogenic marine noise is onboard machinery, especially from diesel engines, and, finally, onboard machines may also cause vibrations that transmit underwater.

ONSHORE AFFECTED ENVIRONMENT

3.11 Onshore Water Resources

This section is limited to discussion of onshore water resources; water resources located offshore are addressed in Section 3.2.

3.11.1 Definition of the Resource

In this document, onshore water resources are defined as the physical and chemical characteristics of any waterbodies or wetlands within, or in the vicinity of, the proposed DOF.

3.11.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to onshore water resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- CWA;
- Rivers and Harbors Act;
- CZMA;
- EO 11988, Flood Risk Management, as amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*; and
- Louisiana State and Local Coastal Resources Management Act of 1978.

3.11.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- USEPA CWA Section 312 Standards for Marine Sanitation Devices,
- USEPA CWA Section 401 Water Quality Certification,
- USEPA CWA Section 402 NPDES permit,
- USACE CWA Section 404 permit,
- Rivers and Harbors Act Section 10 permit,
- FEMA Floodplain Management Consultation, and
- LPDES permit for stormwater management.

The proposed DOF, as well as the coastal portion of the pipeline, is under the jurisdiction of the LDEQ and the Louisiana Office of Coastal Management, Permits and Mitigation Division. The USACE will also have jurisdiction over all water-based construction activities for the proposed Project.

3.11.4 Existing Threats

Estuarine ecosystems are affected by humans, primarily via upstream withdrawals of water for agricultural, industrial, and domestic purposes; contamination by industrial and sewage discharges and agricultural runoff carrying pesticides and herbicides; and habitat alterations (e.g., construction and dredge-and-fill operations). Drainage from more than 40 percent of the contiguous United States enters the Gulf of Mexico, primarily from the Mississippi River. Louisiana and Texas ranked second and first in the nation in 1995 in terms of discharging the greatest amount of toxic chemicals (USEPA 1999). The Gulf of Mexico region ranks highest of all coastal regions in the United States in the number of wastewater treatment plants (1,300), number of industrial point sources (2,000), percentage of land use devoted to agriculture (31 percent), and application of fertilizer to agricultural lands (62,000 tons of phosphorus and 758,000 tons of nitrogen) (NOAA 1990).

The Mississippi River is the primary water body that affects conditions at the proposed Project location. The Mississippi River is 2,302 miles (322 km) long and drains parts or all of 31 states. The Mississippi River is essential to many wildlife species and is habitat for 40 percent of the nation's migratory bird population. The river discharges 612,000 cubic ft (ft^3) of water per second into the Gulf of Mexico. The discharged water is very turbid and full of nutrients, principally nitrogen and phosphorus. These nutrients sustain marine ecosystems in the Gulf of Mexico, but at many times of the year the nutrient level is so high that an area of hypoxia forms in the Gulf south of the Mississippi River Delta.

3.11.5 Existing Conditions

The proposed DOF is located within the Texas-Louisiana Coastal Marshes ecoregion (USEPA 2006) of the Lower Calcasieu watershed, and lies between two major surface water resources. The Sabine River basin and the Calcasieu River basin make up the larger Calcasieu-Sabine Basin where fresh, intermediate and brackish marshes dominate the estuary. Salt marshes also contribute to a smaller portion of the basin. A combination of riverine freshwater drainage, tidal fluctuations from the Gulf of Mexico, precipitation, and wind influence the hydrology of the basin.

3.11.5.1 Surface Water Resources

The primary sources of freshwater inflow to the area are the Sabine, Calcasieu, and Neches Rivers. The Neches River and Sabine River feed Sabine Lake, which is approximately 10 miles to the northwest of the proposed DOF. The Sabine Pass Channel (Sabine Pass) has been extensively modified for navigational purposes, allows for tidal exchange between the marine and estuarine systems, and is connected to the basin of Sabine Lake. This channel is part of an extensive array of canal and waterway systems in the area. Approximately 13 miles west of the proposed DOF and south of Sabine Lake, the Sabine Pass serves as the outlet for this bay-estuary system into the Gulf of Mexico. The extensive marshland present west of the proposed DOF drains into the Lighthouse Bayou, which then flows into the Sabine Pass southwest of the proposed DOF. Overall, the most dominant influence across most of the basin in controlling salinity levels and tides is the Sabine River. This river basin receives freshwater flow from streams and runoff, municipal, industrial and agricultural return flow, and direct precipitation. Approximately 82 percent of the total freshwater inflow to the Sabine-Neches estuary originates from the Sabine and Neches basins. Sabine Lake is also significantly influenced by wind-generated tidal currents from the Gulf of Mexico to back large volumes of Gulf of Mexico water into the Sabine Lake basin. This effect also occurs similarly for Calcasieu Lake. Calcasieu Lake is part of the larger Calcasieu River Basin and is approximately 14 miles east of the proposed DOF. This lake empties into the Gulf of Mexico approximately 30 miles east of the Texas-Louisiana state line, and is influenced by saltwater intrusion in its lower portion. Calcasieu Lake connects to the Gulf of Mexico through the Calcasieu Pass and receives freshwater inflows from the Calcasieu River basin.

Smaller surface waters were also identified in closer proximity to the proposed DOF. Field surveys conducted in December 2014 and January 2015 revealed two waterbodies within and adjacent to the proposed DOF (Table 3.11-1). These waterbodies include an unnamed stream (S-T01-001) that flows east across the southern portion of the PSI Midstream Partners LLC (PSI) Cameron Meadows Gas plant, but falls outside the proposed DOF onshore footprint. In addition, Hamilton Lake (part of the larger Old East Bayou) lies 0.45 mile north of the proposed compressor station and less than 0.1 mile north of the proposed meter station. This lake and its associated canals and tributaries are part of the greater Calcasieu-Sabine basin. Drainage within the Hamilton Lake area comprises an intricate network of bayous and canals of the Calcasieu and Sabine River systems. Review of the USFWS wetland mapper database classifies Hamilton Lake to include areas of lacustrine freshwater and estuarine wetland systems. The freshwater lacustrine portion of Hamilton Lake lies north of the proposed DOF. The extent of any tidal influence within the lake appears limited to drainage areas east of the Magnolia Vacuum Canal.

Table 3.11-1. Waterbodies Within and Adjacent to the Proposed DOF in Cameron Parish, Louisiana a/

Waterbody	Approximate Distance to Proposed DOF Site (miles)	Type	Crossing Width (feet)	State Water Quality Classification(1)	Fishery Type
Hamilton Lake	0.45	Lake	Not Applicable	A, B, C, E**	Warm Water
S-T01-001	0.0	Perennial	Not Applicable	None Identified **	Warm Water

Source: Title 33 Environmental Quality Part IX Water Quality Subpart 1. Water Pollution Control (December 2015)
A - Primary contact recreation (PCR)
B - Secondary contact recreation (SCR)
C - Fish and Wildlife Propagation (FWP)
E** - Oyster propagation only in estuarine water portions (OYS)
**Assumes receiving water classification of A,B,C

The unnamed tributary located on the DOF would not be affected by proposed development activities. Stream drainage was classified as freshwater and associated with PEM wetlands on the DOF.

Surface Water Classification and Quality

Water use designations are applied to listed waterbodies in Louisiana, and include agriculture, drinking water supply, fish and wildlife propagation, outstanding natural resource waters, oyster propagation, primary contact recreation and secondary contact recreation (Louisiana Administrative Code [LAC] Title 33, Part IX, Subpart 1). These designations apply to the entire waterbody as well as its tributaries within a listed sub-segment, with the exception of when unique chemical, physical and/or biological conditions preclude such uses. Water use designations are determined based on various criteria, including but not limited to physiochemical criteria such as DO, pH, and temperatures.

Sabine Pass waters are designated for primary contact recreation, secondary contact recreation, fish and wildlife propagation, and shellfish production uses (LDEQ 2002). The Sabine-Neches Waterway is subject to a phenomenon referred to as a saltwater wedge. This occurs where estuaries with a deep water channel extend into open ocean environments, and as a result water column stratification is often accentuated. Tidal currents and winds from off the Gulf of Mexico act to enhance saltwater intrusion into the lower Sabine-Calcasieu Basin. In response, several water control structures have been installed to control salinity intrusion into the freshwater marshes (LACoast.gov. n.d).

The proposed DOF falls within an estuarine sub-segment 030401 that includes the Calcasieu River-Calcasieu Ship Channel downstream of Moss Lake to the Gulf of Mexico, and is crossed by the Gulf Intercostal Waterway. It is designated as primary contact recreation, secondary contact recreation, fish and wildlife propagation, and oyster propagation, and is not included on the 303(d) List of Impaired Waters. The water quality monitoring site closest to the proposed DOF is Channel Light Number 96, within the Calcasieu River, approximately 0.5 mile upstream from Burton Landing and approximately 30 miles northeast of the proposed DOF. Water quality monitoring has been conducted at this site since the 1970s (LDEQ 2014). Based on the information collected from this monitoring site and the location of the proposed DOF, it was determined that water quality parameters would be relatively similar to the water quality monitoring site at Channel Light Number 96, with increased salinities due to the proposed DOF's proximity to the Gulf of Mexico. Water quality data were collected from July 2013 through February 2014 within the Calcasieu River at the entrance and turning basins within the Industrial Canal (LDEQ 2014). In general, salinity levels and DO were found to be similar to those found within the Calcasieu River upstream from Burton Landing, which is approximately 30 miles northeast of the proposed DOF.

Contaminated Sediments and Water Use

Sediments in portions of the Calcasieu Estuary have historically been contaminated from both point and non-point source discharges. These contaminants include a variety of chemicals, such as heavy metals, PAHs, PCBs, phthalates, chlorinated benzenes, and polychlorinated dibenzo-p-dioxins and dibenzofurans (MacDonald et al. 2011). Historic sediment samples from several river channel stations near the proposed DOF showed that the metals and organic concentrations of contaminants were similar to those collected throughout the Calcasieu River and Pass. In addition, observed concentrations were only slightly greater than the selected reference sites (USACE 2010c). Waterbodies that are located near the proposed DOF are not reported as containing contaminated water and/or sediments (LDEQ 2012). Toxicity of sediments within these waters were not found to be significantly different from controls used in a study conducted in the Sabine Pass and Sabine Lake area (Long 1999; NOAA 2003). The study concluded that sediment quality in the Sabine Lake area was not severely degraded.

During construction, Delfin LNG would need water for hydrostatic testing from nearby municipal/parish sources. Potable water from the Cameron Parish Waterworks District 10 – Johnson Bayou would be the primary source for this supply. This water supply is located approximately 5 miles west of the proposed DOF property boundary. During construction, once the water is used, it would be trucked to a water disposal or cleanup facility. During operation, potable water sources for plant personnel, safety showers, and eyewash stations already exist on-site from the Cameron Parish Waterworks District 10 – Johnson Bayou. The on-site wastewater system would also then receive DOF-generated wastewater.

3.11.5.2 Wetlands

The majority of Louisiana's coastline comprises coastal wetland habitats. These habitats are rapidly being lost due to the combination of land subsidence and sea level rise (StormSmart Coasts Network 2015). Wetland habitats found in the Gulf of Mexico are characterized by their vegetative cover and open water coverage and freshwater input. These include mangroves, marshes (fresh, brackish and salt), mudflats, forested hardwood wetlands and cypress-tupelo gum swamps. These various wetlands can also be classified as estuaries (embayments with substantial freshwater input, representing mixing zones); lagoons (narrow water bodies with high salinities, occurring nearshore); sounds (open-ocean water embayments separated from the sea by barrier islands); and coastal wetlands (salt marsh or wetland communities adjacent to open sea with little protection and beach, with high organic productivity and nutrient recycling).

Wetlands associated with the proposed Project area include scrub-shrub swamp and intermediate marsh. Scrub-shrub swamps are typically characterized by woody vegetation less than 20 ft tall and are low, flat wetlands. Poorly drained soils lead to surface water presence for extended period of time, however sometimes drying does occur during late summer or drought. Environmental conditions in these habitats often cause trees and/or shrubs to be stunted in growth. Vegetative species that typically occur within these wetlands, though are not necessarily present altogether, include buttonbush (*Cephalanthus occidentalis*), silvering (*Baccharis halimifolia*), dwarf palmetto (*Sabal minor*), wax myrtle (*Myrica cerifera*), marsh-elder (*Iva frutescens*), lead plant (*Amorpha fruticosa*) and swamp red maple (*Acer rubrum* var. *drummondii*). Intermediate marshes have salinities that fall somewhere between brackish and freshwater marshes (hence the name) and are still considered as part of a greater estuarine marsh system. These habitats tend to have an irregular tidal regime and are oligohaline (tidal freshwaters). The vegetative species that are found in these habitats are those that are often found in both brackish and freshwater marshes. The dominant species is typically wiregrass (*Spartina patens*), however other species that may be present or dominant include roseau cane (*Phragmites communis*), bulltongue (*Sagittaria lancifolia*), spikesedge (*Eleocharis* spp.), three-cornered grass (*Scirpus olneyi*), and switch grass (*Panicum virgatum*).

Wetlands are areas generally defined as being inundated or saturated by surface water or groundwater at a frequency and duration sufficient to support a prevalence of vegetation typically adapted for life in saturated soil conditions (USACE 1987). Typical wetlands that occur within this coastal environment include mangroves, marshes (fresh, brackish and salt), mudflats, forested hardwood wetlands and cypress-tupelo gum swamps (MMS 2001). Field surveys were conducted on December 2 and 3, 2014, and January 21, 2015 in accordance with the USACE Wetland Delineation Manual (USACE 1987) and the Atlantic and Gulf Coast Plain regional supplement (USACE 2010d). Field surveys were conducted over the entire proposed DOF to determine if primary wetland indicators were observed. A combination of hydrophytic vegetation, indicators of wetland hydrology, and hydric soil indicators were used to delineate wetland boundaries.

A total of 13 wetlands were identified within the Station 44 properties; however, only three of these wetlands occur within the proposed DOF (W-T-01-001, W-T-01-004 and W-T-01-006) property boundary. The total acreage of these wetlands is 4.78 acres. The wetland delineation and acreage remains to be verified by the USACE. It is likely that these wetlands were present on-site prior to construction of the existing operating facilities, and have since decreased in size due to facility operations. Portions of these wetlands that were not currently affected directly have reverted to palustrine scrub/shrub (PSS) wetlands. These PSS wetlands are dominated by shrub species such as wax myrtle (*Morella cerifera*) and silverling (*Baccharis halimifolia*), as well as emergent species. Within the maintained herbaceous portions of the wetlands, the dominant species is bulrush (*Schoeneplectus americanus*). The wetland plant species present were indicative of assemblages both common and native to the wetland cover types identified. Comparison of the observed dominant plant species within the wetlands with the Louisiana invasive plant species list did not identify any invasive species by name. However, a formal invasive species survey was not performed within the wetland areas delineated. Wetlands, especially coastal wetlands, are susceptible to salinity and water level stressors affecting shoreline erosion and saltwater intrusion from rising sea levels. Effects of sea level rise act to alter brackish or freshwater water level and salinity regimes enhancing erosion and altering vegetative communities. These coastal wetlands offer important ecological services through flood control and shoreline buffering, contaminant sequestration, and fish nursery habitats. Development in and around inland freshwater wetlands results in encroachment on these existing habitats and can result in increased stormwater runoff to these habitats and potential introduction of invasive species from application of fill material containing potential seed stock from areas containing invasive species.

3.11.5.3 Groundwater Resources

The proposed DOF is located within the coastal lowlands aquifer system that is one of the most extensively utilized aquifer systems in the southern United States for agricultural, commercial, industrial, and public/domestic supplies (Renken 1998). The mapped hydrologic unit underlying the proposed DOF is the Chicot aquifer, which extends from eastern Texas to the Atchafalaya River in south-central Louisiana. This aquifer is a source of fresh groundwater for industry, agricultural irrigation, domestic use and public supply (Prakken 2003). Historically, flow in the aquifer came from recharge areas north of the proposed DOF. However, increased pumping, primarily for irrigation and industrial use, has altered the flow within the aquifer. The movement of groundwater within the aquifer now flows towards the Lake Charles area, where the greatest pumping occurs (Lovelace et al. 2004).

Within the coastal lowland aquifer stem, dissolved-solids concentrations are directly related to groundwater flow. As waters near the coast and mix with seawater, waters become increasingly more saline. The Chicot aquifer is an USEPA-designated sole source and principal source aquifer under Section 1424(e) of the Safe Drinking Water Act. By definition, sole source or principal source aquifers are designated as those that supply 50 percent or more of the drinking water for an area and for which there are no other reasonably available alternative sources if the aquifer becomes contaminated (53 CFR 20893 06/07/88). Under the Safe Drinking Water Act, the USEPA may therefore review any Federally funded projects in order to prevent possible aquifer contamination.

3.11.5.4 Floodplains

According to the FEMA, National Flood Insurance Program Flood Insurance Rate Map (FIRM), the proposed DOF falls within a designated FIRM zone that is potentially subject to coastal flooding. The entire proposed DOF area is classified as having a 1 percent-annual-chance flood.

3.12 Onshore Biological Resources

This section is limited to discussion of onshore biological resources; biological resources located offshore are addressed in Section 3.3.

3.12.1 Definition of the Resource

This section describes the biotic environment at the proposed DOF. The biological resources described here may be affected by proposed Project construction, operation, and decommissioning, and include upland vegetation, aquatic resources, terrestrial mammals, and birds.

Biological resources include vegetation, fish, and wildlife in the vicinity of the proposed DOF. Inland fish and birds rely on productive coastal ecosystems to sustain viable populations. In particular, wetlands, open waters, and uplands in the vicinity of the proposed DOF provide habitat where fish and bird species forage, shelter, and reproduce. Inland wildlife and fisheries resources in Louisiana are managed by the USFWS and the Louisiana Department of Wildlife and Fisheries (LDWF). Marine and anadromous fisheries are under the jurisdiction of NOAA, as described in Section 3.3.2.

3.12.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to onshore biological resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- National Wildlife Refuge Regulation,
- ESA, and
- MBTA.

3.12.3 Required Permits

No specific Federal or State permits regarding onshore biological resources or threatened and endangered mammals and birds are required; however, Federal agencies must consult with the Secretary of Interior on all actions, or proposed actions, authorized, funded, or undertaken by the agency, that may adversely affect protected species.

3.12.4 Existing Threats

Alterations to numerous waterways and estuaries have caused changes in water flow and increased freshwater volume that not only carries more nutrients into the surrounding marine environment, but also causes loss to wetlands, erosion of barrier islands and degrades estuarine environments (Gulf Coast Ecosystem Restoration Taskforce 2011). Pesticides and other contaminants such as organochlorine, pyrogenic PAHs, herbicides such as Atrazine, PCBs, and trace inorganic (metal) pollutants, can accumulate in sediments and any disruption (i.e., resuspension and mixing) could allow them to re-enter the water column and, thus bioaccumulate and biomagnify, persisting within higher orders of ecological food webs and result in negative consequences to biological resources. In addition, habitat alteration through shoreline erosion and commercial and industrial development, woody species encroachment of lake shorelines and riverbanks, and human disturbance of foraging birds could result in negative consequences to biological resources, including threatened and endangered species.

3.12.5 Onshore Threatened and Endangered Species

The ESA (16 U.S.C. 1531–1534) was established to protect species vulnerable to extinction, as well as their environments. Marine organisms are under the jurisdiction of NOAA Fisheries (see Section 3.3.5), while terrestrial and freshwater organisms are overseen by the USFWS, though some species require special consideration and may be managed by both agencies. The ESA defines “endangered” as a species in danger of extinction in all or a significant portion of its range. “Threatened” is then defined as a species that is likely to become endangered in the foreseeable future. If a Federal agency undertakes an activity that may impact an "endangered" or "threatened" species, they must first consult with the USFWS or NOAA Fisheries, or both, according to Section 7 of the ESA.

Under the ESA, the USCG has the responsibility to determine whether or not the proposed Project would adversely affect Federally listed threatened or endangered species and their critical habitat. If, upon review of existing data or data provided by the Applicant, the USCG determines that either a species or habitat or both might be affected by the proposed Project, the USCG must prepare a BA to consider the type of effect and extent of impact. In addition to an impact analysis, recommendations must be made for ways to eliminate or mitigate potential adverse effects.

The BA prepared by the USCG would aid in the interagency consultation determination of whether the potential impacts from the proposed Project are likely to jeopardize any listed species or result in the destruction or adverse modification of designated critical habitats. After consultation, the Services would issue a BO expressing their opinion about the potential for impacts to occur. If NOAA Fisheries or USFWS determines that the proposed Project would likely negatively impact any listed species or its designated critical habitat, the agency may decide to issue an incidental take statement, which would specify particular exceptions to ESA prohibitions. If the USCG determines that no Federally listed (or proposed) species or designated critical habitat would be affected by the proposed Project, no further action is necessary.

3.12.5.1 Birds

The ESA protects listed fish, wildlife including birds, plants, and invertebrates. A Federally listed endangered species is one that is in danger of extinction throughout all or a significant portion of its range. A Federally listed threatened species is one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range. The USFWS, which is responsible for terrestrial and freshwater species, and NOAA Fisheries, which is responsible for marine species, jointly administer the law.

Federally ESA-listed species with ranges that may overlap with the proposed DOF and adjacent region are listed in Table 3.12-1 (LDWF 2014a,b; USFWS 2012). Both Federally listed and state-listed species that are found more specifically within Cameron Parish, their habitat preferences, and if that habitat is present in the DOF and adjacent region are listed in Table 3.12-2 (LDWF 2014a,b; NOAA Fisheries 2014b; USFWS 2014a). The Federally listed piping plover (*Charadrius melodus*) and interior least tern (*Sternula antillarum athalassos*), as well as the non-ESA but state-listed brown pelican, may fly over the proposed DOF area during migratory or foraging flights but are not expected to use habitats within the proposed DOF.

Because of the normal coastal or nearshore ranges and habitats required by these birds, none of these species are expected to occur near the proposed DOF area though it is possible they could be transient in the offshore areas. The birds with highest likelihood to have an uncommon occurrence in the proposed Project area are highlighted below.

As part of the agency consultation process on the proposed Project, including the proposed DOF under the Commission's jurisdiction, on March 2, 2015, Delfin LNG sent a letter providing details on the proposed Project to the USFWS Louisiana Ecological Services Office located in Lafayette, Louisiana. The USFWS provided a response on March 17, 2015, requesting that the proposed Project evaluate potential impacts on the following species under agency jurisdiction:

- piping plover (Threatened),
- red knot (Threatened), and
- migratory birds (under the MBTA).

Table 3.12-1. ESA-Listed Bird Species Occurring in Coastal Habitats of the Northern Gulf of Mexico

Common Name	Scientific Name	ESA Status	Likelihood of Occurrence
Piping Plover	*Charadrius melodus*	Threatened	Potential
Red Knot	*Calidris canutus rufa*	Threatened	Potential
Audubon's Crested Caracara	*Polyborus plancus*	Threatened	Unlikely. Removed from Consideration
Mississippi Sandhill Crane	*Grus canadensis pulla*	Endangered	Unlikely. Removed from Consideration
Roseate Tern	*Sterna dougallii*	Threatened	Unlikely. Removed from Consideration
Whooping Crane	*Grus americana*	Endangered	Unlikely. Removed from Consideration
Wood Stork	*Mycteria americana*	Endangered	Unlikely. Removed from Consideration
Source: BOEM (2011a)			

Table 3.12-2. Federally Listed and State-Listed Threatened and Endangered Bird Species in Cameron Parish

Common Name	Scientific Name	Federal Status	State Status	Habitat Description	Assessment Result
Piping Plover	*Charadrius melodus*	T	T/E	Beaches and mudflats of barrier islands; forages on aquatic invertebrates.	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Brown Pelican	*Pelecanus occidentalis*	Delisted	E	Occurs in bays, tidal estuaries, or along the coast and commonly nests in shrub thickets within dunes of barrier islands	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Interior Least Tern	*Sternula antillarum athalassos*	E	E	Associated with interior riverine and waterbody habitats. Forage primarily on freshwater species, compared with coastal least tern populations.	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Bald Eagle	*Haliaeetus leucocephalus*	BGEPA	E	Most commonly includes areas close to coastal areas, bays, rivers, lakes, or other large bodies of water that provide concentrations of food sources, including fish, waterfowl, and wading birds. Usually nests in tall trees that provide clear views of the surrounding area.	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Red Knot	*Calidris camutus rufa*	T	--	Includes sandy beaches, tidal mudflats, salt marshes, and peat banks.	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Snowy Plover	*Charadrius alexandrines*	--	S1B, S2N	Winters in habitats with dry, sandy or shell beaches, dry mud or salt flats, and sandy shores of waterbodies where vegetation is sparse.	Suitable habitat for this species is not present within the proposed DOF or adjacent areas.
Key: T = Threatened; E = Endangered; C = Candidate; BGEPA = Bald and Golden Eagle Protection Act; S1B = Critically Imperiled (Breeding); S2N = Imperiled (Nonbreeding); Sources: LDWF (2014a,b); NOAA Fisheries (2014b); USFWS (2014b)					

Piping Plover

The piping plover (*Charadrius melodus*) is a migratory bird; in the spring and summer it breeds in northern United States and Canada, and in the fall it migrates south and winter along the coast of the Gulf of Mexico or other southern locations (USFWS 2015a). This species is Federally listed as threatened with critical habitat designated along the Louisiana coast.

The piping plover winters in Louisiana and Alabama, feeding at intertidal beaches, mudflats, and sand flats with sparse emergent vegetation. The species arrives from their breeding grounds as early as late July and remains until late March or April, approximately 8 to 10 months (USFWS 2015a). There are three piping plover breeding populations and each was Federally listed in 1986. All three populations of piping plover winter along the South Atlantic, Gulf of Mexico, and Caribbean beaches where they spend 70 percent of their time and where they are considered threatened (USFWS 2015b). Critical habitat has been designated for the wintering piping plover at various locations along the Louisiana and Alabama Gulf Coast. Critical habitat for wintering piping plover occurs sporadically along the entire Gulf of Mexico shoreline and includes specific areas that are essential to the conservation of that species. The closest designated critical habitat for this species is in Louisiana Unit 1 (Figure 3.12-1). The piping plover may occur within 1 mile of the proposed DOF and the former UTOS/HIOS pipeline systems crosses through the designated critical habitat onshore. Primary threats to this species are destruction and degradation of winter habitat, habitat alteration through shoreline erosion, woody species encroachment of lake shorelines and riverbanks, and human disturbance of foraging birds.

Due to the piping plover's primary habitat of wide, flat, open, sandy beaches with very little grass or other vegetation with small creeks or wetlands as nesting areas, this species is not expected to occur in the offshore project area located over open waters offshore but may occur in the proposed DOF. Furthermore, the designated critical habitat for the piping plover is not expected to be impacted or adversely affected by the proposed onshore development because the Project would use existing UTOS/HIOS pipeline systems infrastructure without requiring any additional construction in any designated critical habitat for the piping plover.

Red Knot

The red knot (*Calidris canutus rufa*) is a migratory shorebird that breeds in the Canadian Arctic and winters in parts of the United States, primarily using well known spring and fall stopover areas on the Atlantic coast of the United States. The red knot migrates annually between its breeding grounds in the arctic and several wintering regions, including the Northeast Gulf of Mexico (USFWS 2014a). In December 2014, the red knot was listed under the ESA as threatened throughout its range, which includes the entirety of the Gulf of Mexico coastline (USFWS 2014a). No critical habitat is currently designated for this species. Because of the coastal land-based habitats required by the red knot, this species is unlikely to occur in the proposed DOF.

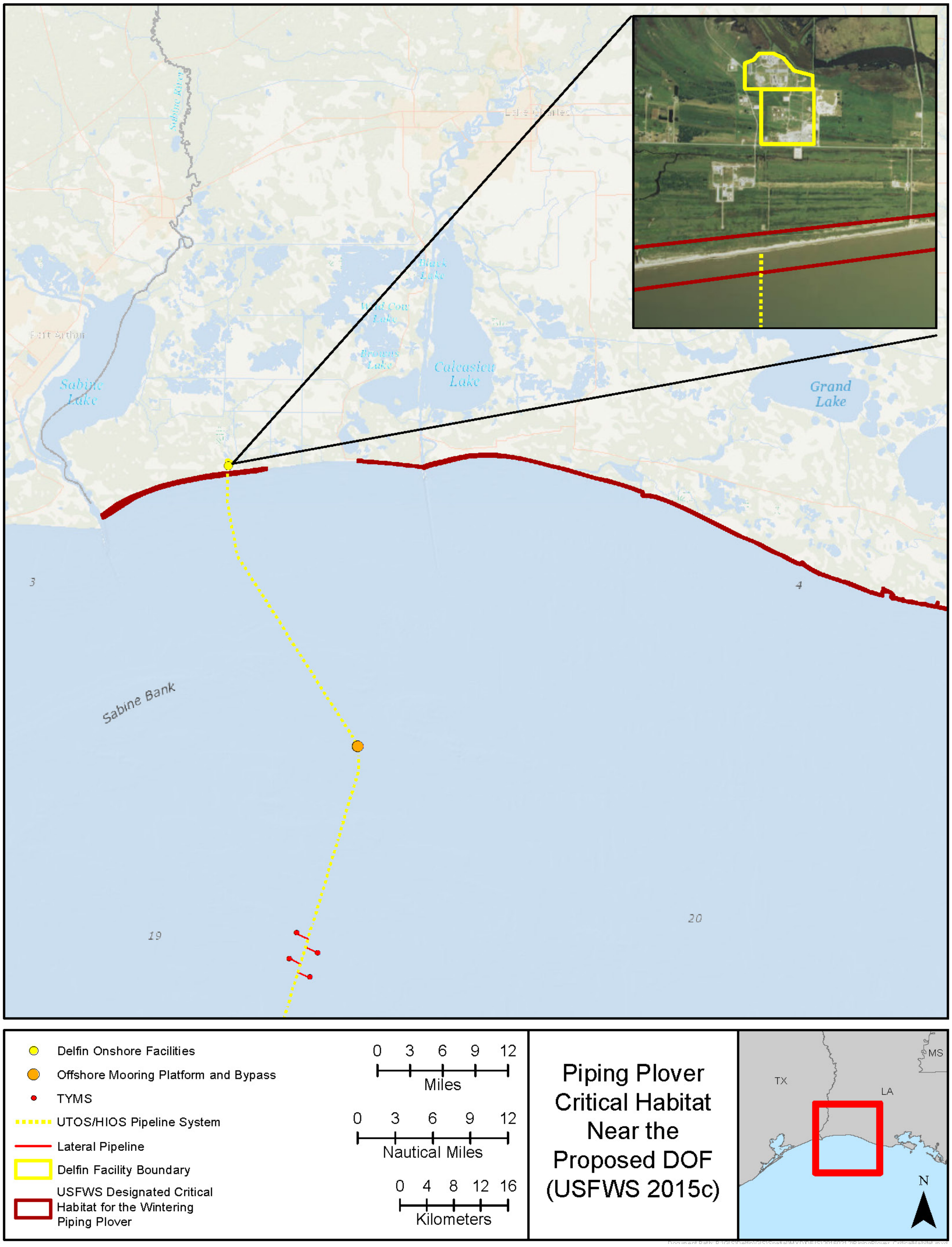


Figure 3.12-1. Piping Plover Critical Habitat near the Proposed DOF (USFWS 2015c)

3.12.6 Terrestrial Mammals (Non-Endangered)

Overall, the region's habitats have been altered by agriculture, the oil and gas industry, and urbanization. The Gulf Coast prairies and marshes in the vicinity of the proposed DOF support common native and non-native wildlife such as waterfowl, wading birds, American alligators (*Alligator mississippiensis*), coyotes (*Canis latrans*), and nutria (*Myocastor coypus*). Other species of small mammals that may occur include otter, deer, mink, muskrat, raccoons, opossums, rabbits, squirrels, skunks, foxes, beavers, armadillos, civet cats, and bobcats. A variety of game birds occur and include quail, turkey, woodcock, and various waterfowl, of which the mottled duck (*Anas fulvigula*) and wood duck (*Aix sponsa*) are native.

Amphibians may also occur within the proposed DOF and could include frog species such as the American bullfrog (*Lithobates catesbeianus*), American green tree frog (*Hyla cinerea*), pig frog (*Rana grylio*), striped chorus frog (*Pseudacris triseriata*) and bronze frog (*Lithobates clamitans clamitans*). There are several toad species that occur such as the Gulf Coast toad (*Bufo nebulifer*), Hurter's spadefoot toad (*Scaphiopus hurterii*) and southern toad (*Anaxyrus terrestris*), and also several salamander species including the eastern tiger salamander (*Ambystoma tigrinum*), southern red-backed salamander (*Plethodon serratus*), dwarf salamander (*Eurycea quadridigitata*), Gulf Coast waterdog (*Necturus beyeri*), and the three-toed amphiuma (*Amphiuma tridactylum*). Reptiles in addition to the American alligator that may occur include several turtle species such as the alligator snapping turtle (*Macrochelys temminckii*), the common snapping turtle (*Chelydra serpentina*), and the razor-backed musk turtle (*Sternotherus carinatus*). The gopher tortoise (*Gopherus polyphemus*) may also occur in the area. Skinks and lizards, such as the American chameleon (*Anolis carolinensis*), are common. Venomous snakes that may occur in the proposed DOF include two vipers: the copperhead (*Agkistrodon contortrix*) and the water moccasin (*Agkistrodon piscivorous*). Common nonvenomous snakes in the vicinity include the common garter snake (*Thamnophis sirtalis*), speckled kingsnake (*Lampropeltis getulus holbrooki*), Texas rat snake (*Elaphe obsoleta lindheimeri*), and the black-masked racer (*Coluber constrictor latrunculus*).

Industrial and road areas are generally not considered habitat in the proposed DOF. Natural communities on the proposed DOF site that may be used as wildlife habitat are dominated by maintained herbaceous vegetation (i.e., mowed grasses), with some areas of coastal dune shrub thicket, and wetlands (see Section 3.11.5.2 for full descriptions). The PSI Midstream Partners, L.P. (PSI) Cameron Meadows Gas Plant and Transcontinental Gas Pipe Line Company, LLC (Transco) Station 44 are fenced off from the adjacent area, limiting access by larger wildlife species.

3.12.7 Avian Resources

Common bird species that are not ESA listed but are considered migratory birds occur in the proposed DOF, such as the eastern kingbird (*Tyrannus tyrannus*) and barn swallow (*Hirundo rustica*).

Migratory birds occur in the proposed DOF. The MBTA (16 U.S.C. 760c–760g), as amended, implements the protection of all native migratory game and non-game birds. The MBTA prohibits the "take" of any migratory bird, part, nest, egg, or product. "Take," as defined in the MBTA, includes any attempt at hunting, pursuing, wounding, killing, possessing, or transporting any migratory bird, nest, egg, or part thereof by any means or in any manner. The MBTA does not explicitly include provisions for permits to authorize incidental take of migratory birds that result from an otherwise legal activity but is not the purpose of the activity. In March 2011, FERC entered into a Memorandum of Understanding (MOU) with the USFWS, as required by EO 13186, which focuses on avoiding and minimizing adverse effects on migratory birds. The MOU does not waive legal requirements under the MBTA or the ESA, nor does it authorize the take of migratory birds; however, it does strengthen migratory bird conservation through collaboration between FERC and the USFWS based on a series of obligations.

Louisiana protections for state-listed endangered and threatened species are contained in Title 56 of the Louisiana Revised Statutes. The regulations were adopted by the Louisiana Wildlife and Fisheries

Commission and the Secretary of the Department of Wildlife and Fisheries. Species listed as state-endangered or threatened are protected from "take" or harassment.

3.12.7.1 Migratory Bird Treaty Act

Birds protected by the MBTA are anticipated to occur and may breed within the proposed DOF. A search was conducted in the USFWS's Information, Planning, and Conservation System (USFWS IPaC 2015) for migratory birds that could occur at the proposed DOF. Species were then examined for nesting range, nesting season, nesting habitat, and potential to occur at the proposed DOF. As shown in Table 3.12-3, six migratory bird species have the potential to nest in the proposed DOF from March through September.

Table 3.12-3. Migratory Birds Potentially Occurring at the Proposed DOF

Species	Project Site within Nesting Range	Nesting Season	Nesting Habitat	Potential Nesting Habitat Present at DOF
American Oystercatcher (*Haematopus palliates*)	No	--	--	--
American bittern (*Botaurus lentiginosus*)	No	--	--	--
Black Skimmer (*Rynchops niger*)	Yes	May to September	Open, sandy substrate; will sometimes nest on mats of dead vegetation on salt marsh islands; usually in the open at least 15 centimeters from vertical objects; often nests in large groups on sandbars	No
Brown-headed Nuthatch (*Sitta pusilla*)	Yes	March to June	Well-decayed snags (pine or hardwood); open areas, wet pine savannas, ponds; will also use nest boxes, fence posts, telephone poles, light poles, and wooden pilings; presence of mature pines within a few hundred meters is essential	Yes
Dickcissel (*Spiza americana*)	Yes	May to August	Dense vegetation of grasses, forbs, or low woody plants; nearly complete overhead cover; low vegetation not directly on the ground	Yes
Gull-billed Tern (*Gelochelidon nilotica*)	No	--	--	--
Henslow's sparrow (*Ammodramus henslowii*)	No	--	--	--
Hudsonian Godwit (*Limosa haemastica*)	No	--	--	--
Le Conte's Sparrow (*Ammodramus leconteii*)	No	--	--	--
Least Bittern (*Ixobrychus exilis*)	Yes	May to August	Dense and tall emergent or woody vegetation less than 10 meters from open water, channels, or muskrat openings	Yes
Least tern (*Sterna antillarum*)	Yes	April to September	Nest areas typically containing shell, gravel, sand, or other fragmentary material; open areas free of vegetation; above high water levels; islands favored when available; prefers sand dunes above high-tide line; sometimes nests on flat rooftops near water	Yes

Table 3.12-3. Migratory Birds Potentially Occurring at the Proposed DOF (continued)

Species	Project Site within Nesting Range	Nesting Season	Nesting Habitat	Potential Nesting Habitat Present at DOF
Lesser Yellowlegs (*Tringa flavipes*)	No	--	--	--
Loggerhead Shrike (*Lanius ludovicianus*)	No	--	--	--
Long-Billed curlew (*Numenius americanus*)	No	--	--	--
Marbled Godwit (*Limosa fedoa*)	No	--	--	--
Nelson's Sparrow (*Ammodramus nelsoni*)	No	--	--	--
Painted Bunting (*Passerina ciris*)	Yes	April to August	Found in low vegetation, less than 2 meters above the ground	Yes
Peregrine Falcon (*Falco peregrinus*)	No	--	--	--
Red Knot (*Calidris canutus rufa*)	No	--	--	--
Red-headed Woodpecker (*Melanerpes erythrocephalus*)	Yes	May to September	Often nests in dead trees or dead portions of live trees; excavate nests vertically with large entrances in dead trees typically without bark	No
Reddish egret (*Egretta rufescens*)	No	--	--	--
Rusty Blackbird (*Euphagus carolinus*)	No	--	--	--
Seaside Sparrow (*Ammodramus maritimus*)	No	--	--	--
Sedge Wren (*Cistothorus platensis*)	No	--	--	--
Short-billed Dowitcher (*Limnodromus griseus*)	No	--	--	--
Short-eared Owl (*Asio flammeus*)	No	--	--	--
Snowy Plover (*Charadrius alexandrinus*)	No	--	--	--
Swainson's Warbler (*Limnothlypis swainsonii*)	Yes	May to August	Near dense growth of cane, vines, shrubs, or other understory vegetation; often associated with canopy gaps; sometimes near (but not over) water; typically suspended by several thin vines or cane	Yes

Table 3.12-3. Migratory Birds Potentially Occurring at the Proposed DOF (continued)

Species	Project Site within Nesting Range	Nesting Season	Nesting Habitat	Potential Nesting Habitat Present at DOF
Swallow-Tailed Kite (*Elanoides forficatus*)	No	--	--	--
Whimbrel (*Numenius phaeopus*)	No	--	--	--
Wilson's Plover (*Charadrius wilsonia*)	No	--	--	--
Worm eating Warbler (*Helmitheros vermivorum*)	No	--	--	--
Yellow Rail (*Coturnicops noveboracensis*)	No	--	--	--
Sources: Cornell Lab of Ornithology 2015; USFWS IPaC 2015				

More than 400 species of birds have been reported in the northern Gulf of Mexico (BOEM 2011a). Many bird species, such as the state-listed brown pelican, may be found in more than one of the five Gulf of Mexico states, while a much smaller subset are largely restricted to a particular state or local area (BOEM 2011a). However, the majority of bird species found in the northern Gulf of Mexico are known to reside primarily in interior or coastal beach and wetland habitats, not over open ocean environments. As mentioned in Section 3.3.7 bird species that may be encountered in the proposed DOF would primarily be shorebirds and seabirds, and some species of migratory birds migrating through the area.

Three orders of seabirds and migratory birds occur in the northern Gulf of Mexico (BOEM 2011a):

- *Procellariiformes* (albatrosses, fulmars, petrels, shearwaters, and storm petrels),
- *Pelicaniformes* (pelicans, tropicbirds, boobies and gannets, cormorants, and frigatebirds), and
- *Charadriiformes* (phalaropes, gulls, terns, noddies, and skimmers).

A substantial percentage of the U.S. population of several species (e.g., neotropic cormorant *[Phalacrocorax brasilianus]*; laughing gull *[Larus atricilla]*; Forster's tern *[Sterna forsteri]*, gull-billed tern *[Gelochelidon nilotica]*, Sandwich tern *[Thalasseus sandvicensis]*, least tern *[Sternula antillarum]*, royal tern *[Thalasseus maxima]*, Caspian tern *[Hydroprogne caspia]*; and black skimmer *[Rynchops niger]*) nests coastally in the Gulf of Mexico, and many others migrate through or winter on the coast. Two bird species are noteworthy but do not have Federal ESA protected status, but are protected under the MBTA: brown pelican (*Pelecanus occidentalis*) and snowy plover (*Charadrius alexandrinus*).

Brown Pelican

The brown pelican is one of two pelican species in North America and is commonly found along the coastline of all states bordering the Gulf of Mexico. For many years, the eastern brown pelican was listed as endangered under the ESA in Mississippi, Louisiana, and Texas (USFWS 2009). However, in November 2009, the USFWS officially removed the brown pelican from the ESA due to its successful recovery (USFWS 2009). Brown pelicans are known to forage as far as 20 miles (32 km) off the shore of the Louisiana Gulf Coast, but are primarily a coastal forager.

Snowy Plover

The snowy plover occurs near the proposed Project area. This species is considered critically imperiled in Louisiana and is state-listed as S1B and S2N. The snowy plover winters along the Gulf Coast and can be found year round in southwest Louisiana. This species occurs on beaches, dry mud or salt flats, and the sandy shores of rivers, lakes, and ponds, and nests where vegetation is sparse or absent. A major threat to the snowy plover is the alteration of coastal habitat.

3.12.8 Upland Vegetation

Louisiana's six ecoregions are characteristic of the broad-scale environmental factors that contribute to the dominant natural vegetation present within the region (Lester et al. 2005). The proposed DOF is located within the Gulf Coast prairies and marshes ecoregion, which includes rivers, lakes, bayous, tidal channels, and canals. Soils in the ecoregion are clayey and poorly drained, and vegetation is dominated by saltwater and freshwater grasslands (e.g., *Spartina* spp.). Other associated vegetative communities are cypress and cypress-tupelo swamps, coastal live oak-hackberry forests, live oak natural levee forests, and bottomland hardwood forests.

The natural communities at the proposed DOF site were surveyed in December 2014 and January 2015 and were classified per the Natural Communities of Louisiana (Louisiana Natural Heritage Program 2009). Non-natural, man-made land covers also were mapped. Figure 3.12-2 illustrates the communities and land covers surveyed. Detailed descriptions of natural communities and man-made land covers in the proposed Project area are also found in Resource Report 8. The following natural communities and land covers are found at the proposed DOF site.

Maintained Herbaceous. This land cover consists of mowed and maintained herbaceous upland areas. Dominant vegetative species include grasses such as *Paspalum* spp. and *Poa* spp.

Coastal Dune Shrub Thicket. Coastal dune shrub thicket is found on stabilized dunes and ridges on barrier islands and the mainland coast and appears as a relatively dense stand of shrubs. This community is typically xeric to xeric/mesic and moderately exposed to salt spray. Typical vegetation includes wax myrtle (*Myrica cerifera*), yaupon (*Ilex vomitoria*), marsh elder (*Iva* spp.), saltbush (*Baccharis halimifolia*), acacia (*Acacia smallii*), and toothache tree (*Zanthoxyllum clava-herculis*). The shrubs are often covered with a dense growth of lichens and vines such as greenbriers (*Smilax* spp.) and wild grape (*Vitis mustangensis*).

Scrub-Shrub Swamp. Scrub-shrub swamp is a low, flat wetland dominated by woody vegetation less than 20 ft tall. These wetlands are often transitional areas between marshes and upland areas such as cheniers. Soils are very poorly drained and surface water is present for extended periods, sometimes drying during late summer or during drought. Species include true shrubs, young trees, and shrubs or trees that are stunted due to some environmental condition(s). Typical vegetative species include buttonbush (*Cephalanthus occidentalis*), silverling (*Baccharis halimifolia*), dwarf palmetto (*Sabal minor*), wax myrtle (*Myrica cerifera*), marsh-elder (*Iva frutescens*), lead plant (*Amorpha fruticosa*), and swamp red maple (*Acer rubrum* var. *drummondii*). All of these are not necessarily seen together at the same site.

Intermediate Marsh. Intermediate marsh consists of estuarine marsh between brackish and fresh marshes, with an average salinity of 3 to 4 parts per thousand. Intermediate marsh tends to have an irregular tidal regime and is oligohaline. This community is characterized by a diversity of species, many of which are found both in freshwater and brackish marshes. It is often dominated by wiregrass (*Spartina patens*), but other species that may be present or dominant include roseau cane (*Phragmites communis*), bulltongue (*Sagittaria lancifolia*), spikesedge (*Eleocharis* spp.), three-cornered grass (*Scirpus olneyi*), and switch grass (*Panicum virgatum*).

Industrial. Industrial land cover is associated with buildings, graveled or paved areas, and other industrial infrastructure.

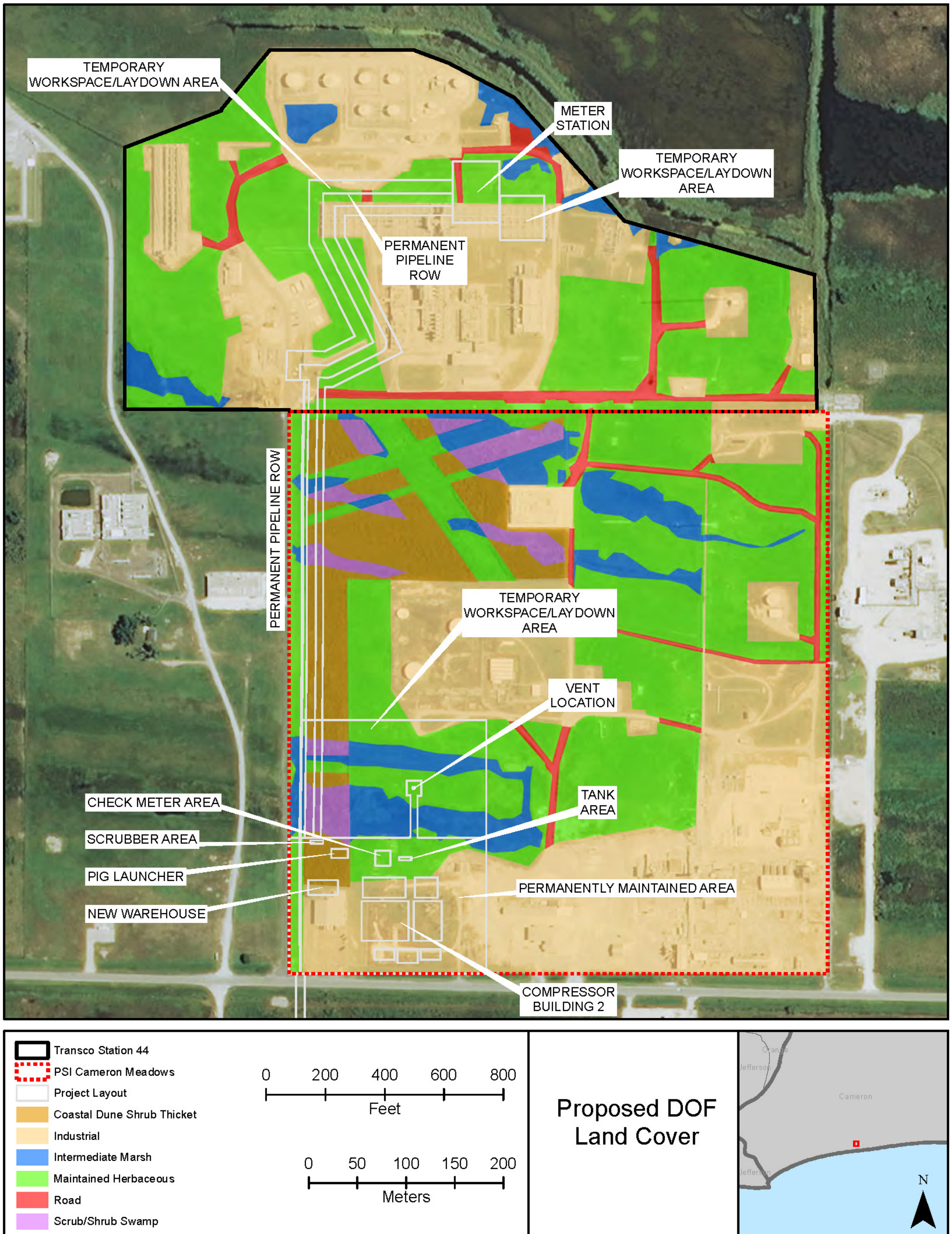


Figure 3.12-2. Proposed DOF Land Cover

Road. Road land cover typically includes improved gravel and asphalt roads that may be associated with industrial or residential land covers.

Estimates of vegetative cover types within the proposed DOF footprint are in Table 3.12-4.

Table 3.12-4. Vegetative Cover Types within the Proposed DOF Footprint

Land Cover Classification	Compressor Station (within DOF Fence Line)			Supply Header Perm. ROW	Supply Header (outside DOF Fence Line)		Facility	ATWS	Total
	Facilities	Permanently Maintained	ATWS		Perm. ROW	Constr. TWS			
Industrial	1.34	3.42	0.14	0.00	0.46	1.03	0.23	0.42	7.04
Road	0.00	0.00	0.00	0.00	0.03	0.03	0.07	0.00	0.13
Maintained Herbaceous	0.11	1.54	2.14	0.07	0.92	1.62	0.45	0.10	6.95
Coastal Dune Shrub Thicket	0.09	0.48	0.32	0.09	0.56	0.50	0.00	0.00	2.04
Scrub/Shrub Swamp	0.00	0.01	0.62	0.15	0.06	0.06	0.00	0.00	0.90
Intermediate Marsh	0.00	0.11	2.05	0.04	0.04	0.06	0.00	0.00	2.30

Key:
ATWS = additional temporary workspace; DOF = Delfin Onshore Facilities; ROW = right-of-way; TWS = temporary workspace

Noxious Weeds. Louisiana Revised Statute 3:1791 lists one noxious plant in Louisiana, the Chinese tallow tree (*Sapium sebiferum*). The presence of Chinese tallow tree was noted throughout forested areas of the proposed DOF site during the December 2014 and January 2015 field surveys. Chinese tallow tree is an aggressive woody invader of wetland, coastal, and disturbed habitats and has been shown to reduce native species diversity and richness and alter ecosystem structure and functionality in natural areas. Chinese tallow tree was first introduced into the United States from Japan and China and was first used as a seed oil crop in the late eighteenth century and then later as an ornamental. Chinese tallow tree is an early successional tree with life history traits that enable it to thrive in unstable or unpredictable environments, e.g., high fecundity, relatively small size, short generation time, and the ability to disperse propagules widely. Chinese tallow tree is a superior competitor in its new range, has virtually no specialist herbivore or pathogen loads, can readily occupy "vacant niches," and can alter ecosystem processes such as nutrient cycling and stand structure. In Louisiana, Chinese tallow tree has been shown to convert herbaceous coastal prairies into closed canopy tallow forests within a decade of establishment, if not controlled (Bruce et al. 1997).

3.12.9 Aquatic Resources

Aquatic resources in the vicinity of the proposed DOF include (1) 4.78 acres of intermittent fishless wetlands and (2) a permanent open water lake that supports a recreational fishery. Each of these aquatic resource types is discussed below.

Almost 5 acres of warmwater, freshwater emergent, and scrub-shrub wetlands occur within the proposed DOF footprint, as shown in Section 3.11.5.2. The wetlands are intermittently ponded and dry, and do not support permanent fish populations. The absence of fish often makes in temporary wetlands suitable spawning locations for amphibians, such as the Gulf Coast toad (*Bufo nebulifer*). Such intermittent wetlands typically provide habitat for flying aquatic insects such as mosquitoes and dragonflies that dominate the lower tiers of the avian food web.

Hamilton Lake provides a perennial warmwater fishery less than 0.5 mile north of the proposed DOF (USFWS 2014b). Hamilton Lake is a lacustrine limnetic waterbody (Wetland Classification code L1UBHh [Cowardin et al. 1979]), which is characterized as a water body larger than 20 acres and deeper than 6 ft with an unconsolidated bottom (USFWS 2014b). This type of water body typically supports recreational fisheries targeting largemouth bass (*Micropterus salmoides),* black crappie (*Pomoxis nigromaculatus*), bluegill (*Lepomis macrochirus*), and warmouth (*Lepomis gulosus*).

3.13 Onshore Geological Resources

This section is limited to discussion of onshore geological resources; geological resources located offshore are addressed in Section 3.5.

3.13.1 Definition of the Resource

This section describes the onshore geologic resources within and surrounding the proposed DOF. Geologic resources consist of the surface and near-surface materials (i.e., rock and soil) of the earth and the regional or local forces by which they are formed. These resources are typically described in terms of regional and local geology, soil resources, topography, mineral and paleontological resources, and geologic hazards. Regional and local geological resources comprise earth materials within a specified region and the forces that have shaped them, including bedrock or soil type and structure, unique geologic features, the depositional or erosional environment, and age or history. Soil resources are considered the unconsolidated terrestrial materials overlying the geology.

Mineral and paleontologic resources include potentially accessible geologic materials with economic or academic value and significant artifacts. Geological hazards comprise the regional or local forces or conditions that could affect a proposed development or use (e.g., seismicity, liquefaction, slope stability, competency of bedrock, and subsidence or settlement).

3.13.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to onshore geological resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- CWA;
- Rivers and Harbors Act;
- CZMA;
- EO 11988, Flood Risk Management, as amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input*; and
- Louisiana State and Local Coastal Resources Management Act of 1978.

3.13.3 Required Permits

No specific Federal or State permits regarding geology and soils are required unless blasting is determined to be necessary.

3.13.4 Existing Threats

Existing threats to geological resources include leaching of toxic substances and pesticides discharged into Gulf of Mexico estuaries from industrial and municipal discharges, urban and agricultural runoff, accidental spills, and atmospheric deposition, as well as various potential impacts from industrial and commercial development within, and in the vicinity of, the proposed DOF. These activities may threaten soil and mineral resources.

3.13.5 Existing Conditions

The proposed DOF site lies within the coastal plain in an area of minimal topographic relief. Elevations within a 5-mile radius of the proposed DOF typically range from 0 to 8 ft North American Vertical Datum of 1988 (NAVD88). The facility ranges in elevation from 3 ft to 8 ft above NAVD88 (FEMA 2003).

The proposed DOF is located in the West Gulf Coastal Plain geomorphic province. The geology consists of Pleistocene and Holocene fluvial, tidal, and deltaic sediments that dip gently toward the Gulf of Mexico. Structurally, the area is a south-dipping monocline with a slight concave-southward curvature. The average regional dip is about 150 ft per mile at depths of 10,000 to 12,000 ft below land surface. The regional dip is interrupted by anticlinal uplifts (many of which are underlain by salt diapirs) and by normal faults that dip predominantly to the south. The Pleistocene and Holocene deposits are underlain by the Fleming Formation (Louisiana Geological Survey 2000). The Fleming Formation is discussed in detail in Section 3.5.5.1.

Surficial deposits in the vicinity of the proposed DOF consist of the Holocene Saline Marsh Chenier Plain deposits. These deposits are unconsolidated, fine-detrital clay or mud and silt from swampy areas of accretion by long-shore currents from major delta complexes (USGS 2009).

3.13.5.1 Soil Characteristics

Soil series descriptions were compiled from information presented in the United States Department of Agriculture National Resource Conservation Service (NRCS) Soil Survey Geographic database for Cameron Parish, Louisiana (NRCS 2013). The database is a digital version of the *Soil Survey of Cameron Parish* (Midkiff and Roy 1995) that was last updated in 2005 (NRCS 2013). The soils at the proposed DOF consist of Hackberry loamy fine sand and the Hackberry-Mermentau complex.

Hackberry Loamy Fine Sand

The Hackberry soil is loamy fine sand with slopes up to 1 percent and found on low beach ridges (NRCS 2013). The parent material consists of sandy beach sand and/or loamy beach sand. Hackberry soils have low shrink-swell potential, are rarely flooded, and have low ponding potential. Throughout the year, a seasonal zone of water saturation is at 30 inches. Hackberry soils are not hydric. Organic matter content in the surface horizon is about 1 percent. Hackberry soils are very slightly saline and have a slightly sodic horizon within 30 inches of the soil surface.

Hackberry-Mermentau Complex, Gently Undulating

The Hackberry component comprises a majority of this NRCS map unit as described above. The Mermentau component makes up 30 percent of the Hackberry-Mermentau Complex (NRCS 2013). The Mermentau component has slopes up to 1 percent and is found on brackish marshes. The parent material consists of loamy over clayey back-swamp deposits. Mermentau soils are poorly drained; throughout the year a seasonal zone of water saturation is at 21 inches. Hackberry-Mermentau Complex soils are hydric. Organic matter content in the surface horizon is about 9 percent. Mermentau soils are moderately saline and have a moderately sodic horizon within 30 inches of the soil surface.

Prime Farmland Soils, Croplands, and Residential Areas

Prime farmland soils are defined as those that are best suited to growing food, feed, fiber, forage, and oilseed crops (NRCS 2013). These soils are of economic importance and generally produce high crop yields. Prime farmland is represented by many soil series and does not need to be actively cultivated to be considered prime farmland. Farmland of statewide importance is land other than prime farmland that has a good combination of physical and chemical characteristics for the production of crops.

Hackberry loamy fine sand is classified as prime farmland and totals 6.34 acres within the proposed DOF. Hackberry complex soils are classified as "Class II w" for field crop suitability. "Class II" soils have moderate limitations on the types of plants that may grow, or moderate conservation practices may be required for plant growth. In "Subclass w" soils, plant growth may be impacted by water in or on the soil. The Hackberry-Mermentau Complex is not classified as prime farmland; these soils have severe limitations that make them unsuitable for cultivation and, similar to Hackberry loamy fine soil, plant growth may be impacted by water in or on the soil.

Areas of the proposed DOF with prime farmland are currently being used for industrial purposes (processing natural gas) and are not being used for agricultural purposes. The prime farmland soils on the proposed DOF site do not have foreseeable potential for agricultural production. The NRCS issued a letter indicating the site is exempt from the Farmland Protection Act because of current and previous land use. Additionally, there are no residential areas within the proposed DOF site.

The acreage and use of these soil series are presented in Table 3.13-1. Soils that are poorly, somewhat poorly, or very poorly drained combined with clay or silt textures have compaction potential. The soils at the proposed DOF are at risk for compaction because they are predominantly clays or silty clays, are poorly drained, and have high shrink-swell potential. The soil limitations related to erosion, compaction, and revegetation are presented in Table 3.13-2.

Table 3.13-1. Soils at the Proposed Project Site

Soil Series a/	Project Component	Acres Temporarily impacted	Acres Permanently Impacted	Farmland Potential	Hydric Characteristics	Comments
Hackberry-Mermentau Complex, Gently Undulating	Compressor Station	4.92	2.91	Not Prime Farmland	Partial Hydric	Hackberry component is not hydric; Mermentau component is hydric
	Supply Header	3.92	0.00			
	Meter Station	0.52	0.75			
Hackberry Loamy Fine Sand	Compressor Station	0.00	4.19	All areas are Prime Farmland	Not Hydric	
	Supply Header	2.15	0.00			
	Meter Station	0.00	0.00			

Note:
a/ NRCS (2013)

Table 3.13-2. Soils Limitations at the Proposed Project Site

Soil Series	Severe Erosion Hazard	Compaction Potential	Rock	Poor Revegetation Potential
Hackberry-Mermentau complex, gently undulating	No	Moderate to Severe	None	No
Hackberry loamy fine sand	No	Moderate	None	No

Note:
a/ NRCS (2013)

3.13.5.2 Geologic Hazards

Potential geologic hazards generally include bathymetry, ground failure caused by unstable soils (slope instability), seismicity (earthquakes), shallow gas and gas hydrates, diapiric structures volcanism, or human activities (mining and blasting). As discussed earlier in Section 3.5.5.4, the southern coast of the United States is a passive tectonic margin compared to an active tectonic margin like the western coast of North

America that is subject to geologic uplift, volcanism, and high levels of seismic activity. These hazards are summarized in Table 3.13-3 and discussed in detail below.

Table 3.13-3. Natural Subsurface Hazards Summary

Hazard	Definition	Identified / Description
Shallow faults, faulting attenuation	A fracture or fracture zone along which there has been displacement of the sides relative to one another, parallel to the fracture; attenuation is the translation of movement along a fault into surrounding mediums.	Present
Mass movement structures (slump, slide)	Often distinguished by a single coherent mass of material displaced from its original location, in which the sediment/rock mass remains virtually intact and moves outward and downward.	Not present

Faults and Seismicity

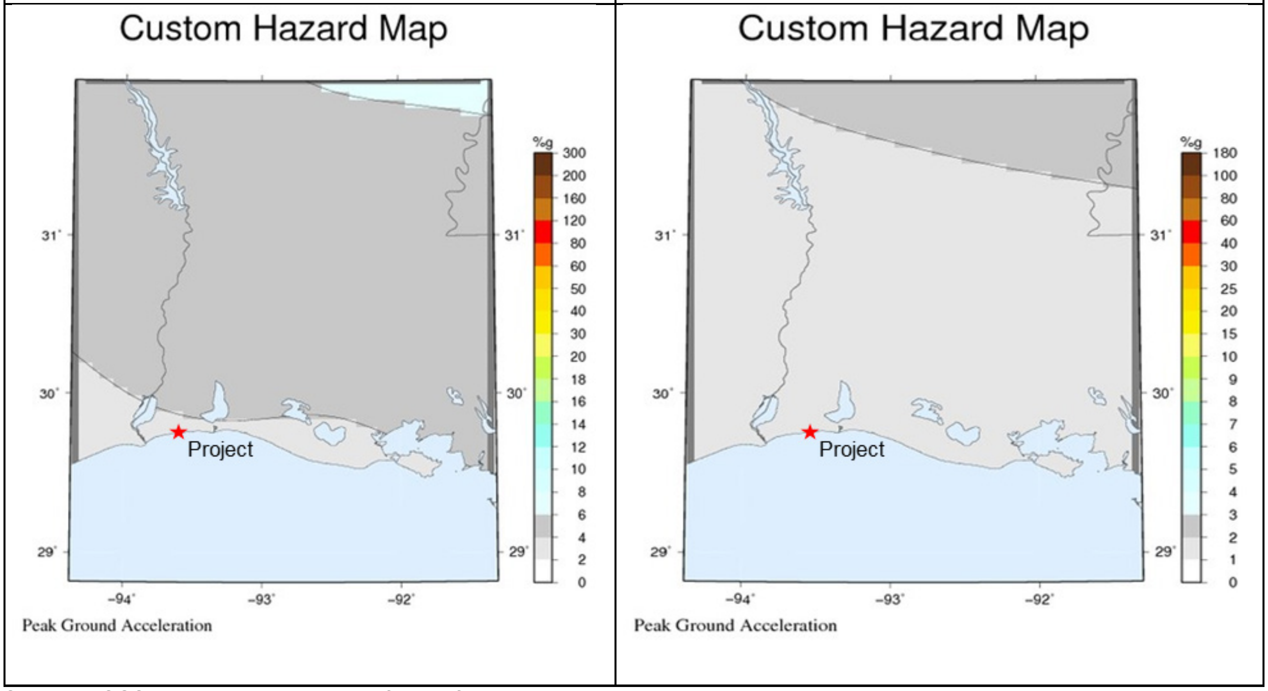
A belt of mostly seaward-facing normal faults borders the northern Gulf of Mexico in the area of Louisiana and Texas. A detailed discussion of these faults and their origin is presented in Section 3.5.5.

The coastal zone of Quaternary faulting that covers southern Louisiana, coastal Texas, and their offshore extensions is separated from the interior zone of Quaternary faulting by the Early Cretaceous shelf edge. This zone of gulf-margin normal faults is believed to be mechanically decoupled from the underlying crust, as indicated by fault slips and well bore breakouts from deep drill-hole data (Wheeler and Heinrich 1998). The closest faults are an east-west trending growth fault located 6.3 miles north of the site, an east-west trending growth fault located 14.3 miles south of the site, and a northeast-southwest trending growth fault located 16 miles southeast of the site (USGS 2009).

The proposed DOF is in the Gulf Coast Basin, which has very few incidents of seismic activity. The largest earthquake occurred on the Texas-Louisiana border with a 4.4 body-wave magnitude during the construction of the Toledo Bend and Sam Rayburn reservoirs (Stevenson and McCulloh 2001). The nearest recorded earthquake to the proposed Project was a 3.8 magnitude that occurred on the east side of the Sulphur Salt Dome and caused hairline cracks in brick and stone fences (USGS 1987). Some of the seismicity in this normal fault belt may have been artificially induced (USGS 1987).

The USGS Hazard Mapping Program (2008b) probabilistic seismic hazard analyses for peak ground acceleration (pga) expected at the proposed DOF, expressed as a factor of gravity (g), indicates a 10 percent probability of exceedance is 0.0124g for within a 50-year period and 2 percent probability of exceedance of 0.0388g for within a 50-year period (Figure 3.13-1).

2% Probability of Exceedance in 50 years	10% Probability of Exceedance in 50 years



Source: USGS (2008b), expressed as a factor of gravity (g), the higher the percent the greater the acceleration.

Figure 3.13-1. Probabilistic Seismic Hazard of Peak Ground Acceleration

Soil Liquefaction

The proposed DOF is underlain by saturated soils that are texturally fine in nature. Structures constructed at the site could be susceptible to liquefaction under sufficiently strong ground motion. However, the relatively low levels of seismic activity and possible ground motion predicted for the site indicate that the presence of necessary liquefaction criteria would be limited and the risk of soil liquefaction at the site is minimal.

Tsunami

The tsunami hazard associated with earthquake sources (i.e., offshore faults) is generally thought to be small, but submarine landslides along the Continental shelf in the Gulf of Mexico are considered a more likely source of tsunami hazards at the proposed DOF. Given the long recurrence interval of large submarine slides, it is expected that the tsunami hazard at the site is unlikely to be significant at the relatively short return periods.

Ground Subsidence

Subsidence resulting from solution mining poses no risk of subsidence at the proposed DOF. The nearest salt domes are the Black Bayou Dome, located 19.2 miles north of the proposed DOF, and the West Hackberry Dome, located 22.4 miles northeast of the proposed DOF (LDNR 2012). No karst terrain underlies the proposed DOF so there is no potential for subsidence due to collapse of karst structures (Hosman 1996).

Area subsidence in southwest Cameron Parish is 0.39 to 0.71 inch per year. The subsidence is the result of regional sediment and water load-induced flexure of the lithosphere and local processes, including compaction, organic soil oxidation, faulting, oil and gas extraction, aquifer withdrawal, and solution mining (Shinkle and Dokka 2004). Subsidence due to compaction, settlement, and shearing of the unconsolidated sediments under the proposed DOF is a potential occurrence and would be taken into consideration during facility design.

Flooding

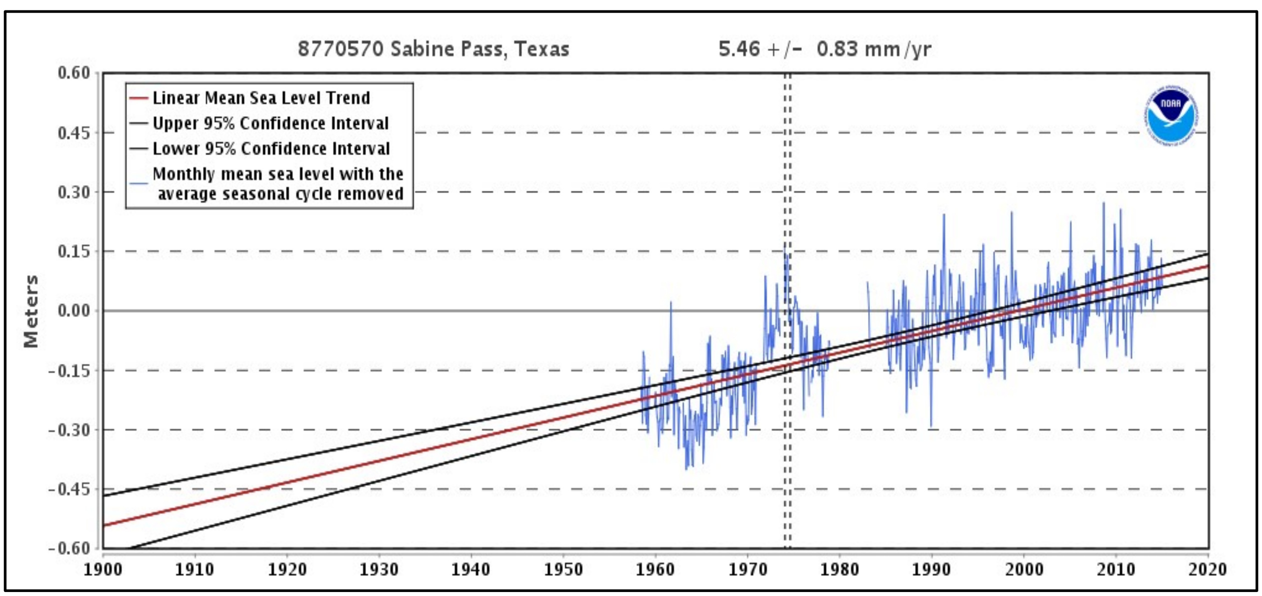
FEMA has selected flood events of a magnitude that are expected to be equaled or exceeded once on the average during any 10-, 50-, 100-, or 500-year period (recurrence interval) as having special significance for floodplain management and for flood insurance rates. These events, commonly termed the 10-, 50-, 100-, and 500-year floods, have a 10 percent, 2 percent, 1 percent, and 0.2 percent chance, respectively, of being equaled or exceeded during any year. In an effort to standardize threat assessment and to provide a national standard, FEMA has adopted the 1 percent annual flood or 100-year recurrence interval as the base flood for floodplain management purposes. The 0.2 percent annual-chance flood (500-year recurrence interval) is used to indicate additional areas of flood risk in a community. The 1 percent annual-chance floodplain boundary corresponds to the boundary of the areas of flooding hazards (Zones A, AE, AO, and VE), and the 0.2 percent annual-chance floodplain boundary corresponds to the boundary of areas of moderate flood hazards.

FEMA has updated the maps for Cameron Parish in November 2012, using data from their detailed study of the existence and severity of flood hazards in the geographic area of Cameron Parish. The FIRM maps indicate that the proposed DOF has been delineated as flood Zone AE.

This represents the area with a 0.1 percent annual-chance flood, the expected 100-year flood event levels, with depth of less than 1 ft, or an area protected by a levee from a 1 percent annual-chance flood. The proposed DOF has a base flood elevation of 12 to 14 ft NAVD88. This base flood elevation represents the expected water elevation from a 100-year flood event (FEMA 2012).

Flooding from storm surges may be a significant source of flooding near the proposed DOF. The peak storm surge during hurricanes Rita and Ike in the region of the proposed Project were 14.9 ft and 16.5 ft above mean sea level respectively (USGS 2005, 2008a). NOAA storm surge modeling predicts that the maximum envelope of water from a Category 5 hurricane crossing Cameron Parish northwest at 10 miles per hour at mean tide could produce a storm surge of up to 21.6 ft above NAVD88 at the proposed DOF (NOAA 2012).

The NOAA Sabine Pass Station 8770570, which is near the proposed DOF location, has monitored the monthly mean sea level without the regular seasonal fluctuations due to coastal ocean temperatures, salinities, winds, atmospheric pressures, and ocean currents since 1958 (NOAA 2015b). Figure 3.13-2 shows the long-term linear mean sea-level trend, including the 95 percent confidence interval.



Source: NOAA (2015b)

Figure 3.13-2. Mean Sea Level Trend Station 8770570 Sabine Pass, Texas

The mean sea level trend is 5.46 mm/year with a 95 percent confidence interval of ±0.83 mm per year based on monthly mean sea level data from 1958 to 2013. This is equivalent to a change of 10.7 inches in 50 years; however, the confidence level decreases as the projection progresses in time.

Erosion and Landslides

Landslides include a wide range of ground movement, such as rock falls, deep failure of slopes, and shallow debris flows. Although gravity acting on an over-steepened slope is the primary reason for a landslide, there are other contributing factors:

- slopes of soil or unconsolidated sediments weakened through water saturation,
- erosion by energetic water action undercutting slopes,
- seismic activity generating stresses that cause failure of weak slopes, and/or
- excess weight from overburden, structures, or other loads, which may cause failure of weak slopes.

The proposed DOF is located in an area of low topographic relief. The USGS National Landslide Hazards Program's Landslide Inventory Map (USGS 2002) indicates the proposed DOF is located in an area of low landslide incidence (i.e., less than 1.5 percent of the area has experienced landslides) and low landslide susceptibility. Localized slumping could occur at areas of steep sloped banks of local waterways.

Blasting

Due to the absence of bedrock, glacial moraines, or similar obstructions within the proposed DOF's construction depth, no blasting is anticipated. If it is determined that blasting is required for construction of the proposed Project, a blasting plan would be prepared and submitted to FERC and MARAD for approval before conducting any blasting activities.

3.13.5.3 Mineral Resources

Salt accounted for 40 percent of Louisiana's total non-fuel mineral value in 2009 and was the leading non-fuel raw mineral (USGS 2013). Salt surpassed construction sand and gravel, which had been Louisiana's leading non-fuel mineral. In 2009, construction sand and gravel was the second leading mineral commodity, accounting for 36 percent of Louisiana's total mineral value. Crude gypsum, lime, stone (i.e., crushed limestone and sandstone) accounted for 18 percent of the non-fuel mineral value. Industrial sand and gravel and common clays account for 5 percent of the value, and natural gemstones account for the remaining 1 percent.

A review of the USGS Mineral Resources Data System (2014) indicates that no mineral resources occur within 0.25 mile of the proposed DOF. The nearest non-fuel mineral resource is the South Johnson's Bayou Geothermal Prospect, located in Cameron Parish 5.3 miles west of the proposed DOF. No additional non-fuel mineral resources are located within 15 miles of the proposed DOF.

The proposed DOF is located on the southeast edge of the Smith Ridge oil and gas field. Although there are more than 7,500 active and historic oil/gas and injection wells in Cameron Parish no active wells are located within 0.25 miles of the proposed DOF (LDNR 2014). There are three dry and plugged oil/gas or injection wells within 0.25 mile of the proposed DOF.

Coal is a significant mineral resource in Louisiana, but coal-bearing regions are limited to the northern half of the state (EIA 2014c). Two coal mines in the northwestern portion of Louisiana supply lignite coal to the Dolet Hills power plant, which is approximately 150 miles north of the proposed DOF.

No important or recognized significant paleontological resources have been identified at or nearby the proposed DOF (Hosman 1996). The Pleistocene strata underlying the proposed DOF are typically not fossiliferous. Rare beds containing brackish and marine mollusks occur farther north in nearshore marine deposits of the Prairie Complex (Saucier 1994). Due to the lack of geologic outcrops in the proposed DOF and the prior disturbance of the proposed DOF, the potential for disturbance of significant paleontological resources is very low.

3.14 Onshore Cultural Resources

This section is limited to discussion of onshore cultural resources; cultural resources located offshore are addressed in Section 3.6.

3.14.1 Definition of the Resource

Cultural resources include archaeological sites (prehistoric and historic; terrestrial and marine), historic standing structures, objects, districts, traditional cultural properties and other properties that illustrate important aspects of prehistory or history or have important long-standing associations with established communities or social groups. Significant archaeological and architectural properties are usually defined by eligibility criteria for listing on the NRHP and in consultation with the Louisiana Office of Cultural Development, Division of Historic Preservation, which functions as the SHPO in Louisiana. Projects that require Federal permits or occur on Federal lands require consultations by the Federal agency, with SHPO, and interested Native American tribes under Section 106 of the NHPA of 1966 (as amended). As lead Federal agencies, the USCG and MARAD would determine if the permitting of the proposed Project would adversely affect cultural resources that are listed in or potentially eligible for listing on the NRHP. The APE on archaeological resources for the proposed DOF, as specified in Section 106 of the NHPA, includes all onshore locations that would undergo Project-related disturbance that could result in changes in the character or use of historic properties. In addition, under the NRHP, undertakings include new and continuing projects, activities, or programs and any of their elements not previously considered under Section 106.

3.14.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to onshore cultural resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- NHPA Section 106;
- EO 11593, *Protection and Enhancement of Cultural Environment*;
- Historic Sites Act of 1935 (16 U.S.C. 461 et. seq.);
- Determination of Eligibility for Inclusion on the NRHP (36 CFR 63);
- Recovery of Scientific, Prehistoric, and Archaeological Data (36 CFR 66);
- Curation of Federally Owned and Federally Administered Archaeological Collections (36 CFR 79);
- Protection of Historic Properties (36 CFR 800); and
- The Louisiana Archaeological Resources Act (Title 41 Chapter 13 § 1601, et seq.).

3.14.3 Required Permits

As discussed in Section 3.6.3, projects that would be considered a Federal undertaking (i.e., projects that require Federal permits, receive Federal funding, or occur on Federal lands) require consultations by the lead Federal agency, with SHPO, and interested Native American tribes under Section 106 of the NHPA of 1966 (as amended). The Federal agency must take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the NRHP. The ACHP must be given an opportunity to comment on the project.

3.14.4 Existing Threats

Existing threats include potential adverse impacts from ground-disturbing activities due to commercial, industrial, and residential development within the vicinity of the proposed DOF, including ongoing oil and gas activity. As well as, the construction of onshore project facilities and pipelines that could impact visual aesthetics of the surrounding environment.

3.14.5 Existing Conditions

Existing conditions include any onshore cultural resources that may exist within or in the vicinity of the proposed DOF and are discussed in the following subsections.

3.14.5.1 Cultural Context

Louisiana prehistory is summarized by the Louisiana Archaeological Survey and Antiquities Commission (Neuman and Hawkins 1993). The earliest known habitation of North America was by small groups of hunters and foragers who occupied a variety of areas across the continent during the late Pleistocene and early Holocene periods. Paleo-Indian hunters and foragers reached the northern Gulf of Mexico by around 12,000 years ago. Sites related to Paleo-Indians include distinctive tool types including variations of fluted stone points skillfully made from selected stone types that may have been carried into the Louisiana area from Texas and Arkansas. Some of the later Paleo-Indian sites contain artifacts made of more local stone materials. Sometime around 8,000 years ago, as shown by artifact distributions in the archaeological record, stone tools referred to as of the Archaic Period (also known as the Meso-Indian Period) indicate that small nomadic groups occupied geographical areas for longer periods of time, sometimes revisiting preferred sites located near streams and along the coastline where shellfish, fish, and deer were available year-round. Resources such as seeds, roots, nuts, and fruits were also part of their diet. Through time, stone point types became smaller, were chipped from local stone, and were propelled by attachment to an atlatl (spear thrower). Additional technological innovations included development of a variety of new stone tool types, including grinding stones and stone axes, and the development of baskets for carrying and storing seeds, roots, fruits and nuts. Populations expanded over time and groups remained in one place for longer periods, sometimes creating earthen mounds during multiple stages of construction. Presumably, the presence of singular and sometimes multiple mounds in individual sites reflect greater complexity of social organization. From 4,000 years ago to about 1600 AD, during the Neo-Indian Period, populations expanded with some groups becoming sedentary. Distinctive cultural traits represented by tool and pottery types, the types of earthworks they created, and the practice of varying degrees of agriculture, characterized the Poverty Point, Tchefuncte, Marskville, Troyville-Coles Creek, Caddo, and Plaquemine-Mississippian cultures. While type sites of these cultural groups are not known in the immediate area of the proposed DOF APE, there is potential for sites related to any of these groups to be located near or within the APE.

General trends of development during the historic period are summarized by the Louisiana Office of Cultural Development (LOCD 2011). European contact with Native American populations, from about 1500 to 1700 resulted in the collapse and social dislocation of Native American people and devastation due to warfare, disease, and cultural loss. Spanish explorers were the first Europeans to influence the area. This was followed by contact with the French, additional Spanish influx, and the British. Colonial development in Louisiana took place from about 1699 through 1812 and is evident still in architectural developments related to European and African cultural interaction in the state. From the period between 1812 and 1860, Louisiana became a distinctive commercial region with an economy based upon cotton, sugar, and enslaved labor. The European origins of landowners influenced the styles in which structures and complexes of structures were created. Even into the late eighteenth and nineteenth centuries, communities with distinctive ethnic identifies and customs persisted into the twenty-first century. From the time of the Colonia Era through the nineteenth century, the state of Louisiana played a strategic role in defense of the country against incursions by foreign entities. Military posts were developed in strategic locations to defend commercial centers, ports and harbors, and cities from takeover by foreign nationals. The state also contains nationally significant battlefields where military actions took place. Following the Civil War, from 1865 to the present day, African Americans and local Euroamerican populations have experienced cultural tensions that very much influenced settlement patterns, resource exploitation, and social tensions. Technological innovations in transportation and communication during the early-to-mid twentieth century introduced further outside influences to all areas of the state of Louisiana. The oil and gas industry in Louisiana influenced the creation of public architecture and also land uses in various areas, including within the proposed DOF's APE. Post-World War II development of the interstate highway system resulted in the expansion of the development of suburbs surrounding cities and the expansion of businesses to service these new suburban populations.

3.14.5.2 Onshore Cultural Resources Assessment

A Phase I cultural resources survey was performed by Delfin LNG's contractor R. Goodwin and Associates (Boyko et al. 2015). The investigation included a review of previous cultural resources investigations, known archaeological sites, and historic architectural properties within or adjacent to the APE. Based on these data and environmental characteristics of the APE, and historic and prehistoric settlement pattern information, a preliminary predictive model for the presence of cultural resources within the proposed DOF's APE was developed. The proposed DOF's APE was characterized as a having a high probability for containing cultural resources. The parcels that comprise the proposed DOF's APE were examined using systematic shovel testing and pedestrian survey. No previously identified or newly identified archaeological resources were found within the southern parcel of the proposed DOF's APE. The northern parcel of the proposed DOF's APE was shovel tested, walked over, and photo-documented. The investigation revealed that a previously identified archaeological site (16CM84) extended within the proposed DOF's APE. Avoidance of this site was recommended. In a letter dated December 4, 2015 (see Appendix D), the Louisiana SHPO indicated the eligibility of this site was undetermined, and that if the site could not be avoided by construction, additional investigations would be necessary. Delfin LNG has indicated the site would be avoided through site layout and implementation of a site avoidance plan (see Section 4.14.1).

3.15 Land Uses, Onshore Recreation, and Onshore Visual Resources

This section is limited to discussion of land use, onshore recreation, and onshore visual resources; land use, onshore recreation, and onshore visual resources located offshore are addressed in Section 3.7.

3.15.1 Definition of the Resource

Land use resources encompass the natural and man-made entities that define the region, including land cover, land ownership, and commercial/industrial, agricultural, and residential use.

Recreational resources include natural and man-made entities that offer visitors and residents diverse opportunities to enjoy leisure activities. Onshore recreational resources include national or state parks, recreational facilities, boat landings, and beaches.

Visual resources refer to the composite of basic terrain, geologic features, hydrologic features, vegetative patterns, and man-made features that influence the aesthetic character and quality of an area. NEPA regulations require that aesthetic impacts be identified and considered when determining project impacts. Marine areas offer visual resources to boaters, birds, and beachgoers. Visual impacts are a function of the visual resources present as well as the number, preferences, and sensitivity of potential viewers.

3.15.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to land use, onshore recreation, and onshore visual resources (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- CZMA,
- Cameron Parish Coastal Resource Management Plan,

- Louisiana State and Local Coastal Resources Management Act, and
- Texas Coastal Coordination Act.

3.15.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- Rivers and Harbors Act, Section 10 Permit; and
- Coastal Use Permit.

3.15.4 Existing Threats

Existing threats include potential adverse impacts from commercial, industrial, and residential development within the vicinity of the proposed DOF, including ongoing oil and gas activity. As well as, the construction of onshore project facilities and pipelines that could impact visual aesthetics of the surrounding environment.

3.15.5 Land Uses

The region surrounding the proposed DOF is rural and characterized by open space, open water, industrial gas facilities, and rural residences. Within the proposed site, there are intermediate wetlands and scrub-shrub swamp. No residences are adjacent to the proposed site, and no planned residences are located within 0.25 mile. The closest residence is approximately 0.55 mile west of the proposed DOF. Additionally, there are no other commercial businesses or planned commercial businesses within 0.25 mile of the site, beyond the existing industrial oil and gas facilities.

The proposed DOF is sited entirely on private lands. No other lands administered by Federal, State, local agencies, or private conservation agencies, including national or state parks and forests, Indian reservations, wildlife management areas, wilderness areas, and nature preserves, are located within the proposed DOF or within 0.25 mile of it.

No designated natural or scenic areas or registered natural landmarks (i.e., National Wild and Scenic River System, the National Trails Systems, or the National Wilderness Preserve System) are within the proposed DOF site or within 0.25 mile of it. No historic sites, historic parks, or Federally or State-recognized historic resources are located within the proposed DOF or within 0.25 mile of it.

The nearest conservation easements are found within the boundaries of the Sabine National Wildlife Refuge approximately 11 miles to the north. The nearest state park, preservation, or historic site is the Sam Houston Jones State Park, approximately 43 miles to the northeast in Lake Charles.

The Peveto Woods Migratory Bird Sanctuary is 1.7 miles east of the proposed DOF, south of State Route 82. The property is managed by the Baton Rouge Audubon Society and encompasses 40 acres of habitat for migratory birds. This site is a significant stopover and resting area for neotropical migratory birds and migratory monarch butterflies.

Delfin LNG currently has no plans for future expansion or abandonment of the proposed DOF. If a decision is reached to expand or abandon the proposed DOF, Delfin LNG would seek all appropriate authorizations from Federal, State, and local agencies.

There would be no need for any new or expanded construction, laydown, or parking areas to construct the proposed Project. Delfin LNG would use existing Gulf of Mexico fabrication and pipeline yards. The U.S.-based construction associated with the proposed Project would be limited in scope and could be accommodated within the existing permitted footprints of several existing offshore fabrication and pipeline facilities.

3.15.6 Onshore Recreation Resources

No national or state parks and forests or nature preserves are located at the proposed site of the proposed DOF or within 0.25 mile of the site.

The Johnson Bayou Community Center (located at 5556 Gulf Beach Highway, Cameron, Louisiana) is located on the proposed DOF site. The Community Center can hold approximately 200 people and is managed by Cameron Parish. The building is used weekly for church services and a church youth group and, on average, monthly for other events such as parties and weddings. The building is used primarily on weekends, with the exception of the youth group meetings on Monday evenings. Delfin LNG proposed to relocate the Community Center and to reuse the existing building as an office building. Delfin LNG is currently negotiating with the Johnson Bayou Recreation District regarding the sale of the building and the construction of a new building at a different location in Johnson Bayou. Delfin LNG would also construct a new, ground-level warehouse. The warehouse would be 50 ft by 100 ft with a total height of 35 ft above the ground surface.

The nearest recreational facility is the Johnson Bayou Recreation Center, 3.8 miles to the west at 135 Berwick Road, Johnson Bayou. The Recreation Center provides an indoor gym, an outdoor pool, and community activities. Five public beaches along the Gulf of Mexico are within 4 miles of the proposed DOF: Long Dun Beach (0.8 mile), Mae's Beach (1.5 miles), Little Florida Beach (2.0 miles), Gulf Breeze Beach (2.8 miles), and Constance Beach (3.6 miles).

The nearest public boat landing is the Deep Bayou Landing, 6.6 miles west of the proposed DOF. Other public boat landings in the region include Sabine Pass (approximately 15 miles to the west) and the Davis Road boat launch (approximately 18 miles to the east). The Cameron Jetty Pier is located 18 miles to the east and is managed by Cameron Parish as a fishing pier, with facilities for boat launching, picnicking, and camping (i.e., a recreational vehicle park). The Cameron Jetty Pier hosts the annual Cameron Saltwater Fishing Festival in August.

The Sabine National Wildlife Refuge and Sabine Wildlife Management Area are north of the proposed DOF, approximately 4.9 miles and 26 miles, respectively. Texas Point and McFaddin National Wildlife Refuges are located within 20 miles of the proposed DOF. These refuges supply important feeding and resting habitat for species and offer educational and recreational opportunities through visitor centers.

Offshore recreation resources including fishing, scuba diving, and cruise ships are discussed in Section 3.7.6.

3.15.7 Onshore Visual Resources

No nationally or state-designated visual resources or visually sensitive areas such as natural landmarks, scenic roads, trails, or scenic rivers are within the proposed DOF. State Route 82 is adjacent to the south boundary of the proposed DOF and is part of the Creole Nature Trail Scenic Byway. The proposed DOF site is within the Creole Nature Trail Scenic Byway's viewshed. The Creole Nature Trail All-American Road includes state routes and roads throughout Cameron and Calcasieu Parishes and was designated a state scenic route by the Louisiana legislature in 1993 and was recognized as a National Scenic Byway by the Federal Highway Administration's America's Byways program in 1996. In 2002, this designation was upgraded to an All-American Road. No other Federally, State-, or locally designated visual resources have been identified in the vicinity of proposed Project facilities.

3.16 Onshore Air Quality

This section is limited to discussion of onshore air quality; offshore air quality is addressed in Section 3.9.

3.16.1 Definition of the Resource

In this document, air quality is defined as a measurement of pollutants in ambient air. Air quality as described here may be affected by proposed Project construction, operation, and decommissioning. Carbon dioxide, sulfur dioxide, ozone, particulate matter, and heavy metal emissions are some of the potential hazards that can negatively impact air quality. Degradation of air quality can negatively impact human health and wildlife. Also, emissions can potentially contribute to climate change.

3.16.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to onshore air quality (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- Clean Air Act, including:
  - NAAQS,
  - AQCRs,
  - NSPS,
  - NESHAP, and
  - General Conformity;
- Louisiana Ambient Air Quality Standards (LAAQS); and
- Louisiana Emission Standards and Requirements.

3.16.3 Required Permits

For compliance with the abovementioned laws and regulations, Delfin LNG may be required to obtain the following permits prior to construction:

- PSD Permit
- Title V Operating Permit

3.16.4 Existing Threats

Existing threats to onshore air quality include both commercial and private sources. The project area is industrial, with multiple compressor stations and other emission-producing energy infrastructure. Vehicle traffic, both private and commercial, also contribute to emissions in the area.

3.16.5 Existing Conditions

Existing conditions, including onshore regional climate, existing ambient air quality, and greenhouse gasses and climate change are discussed in the following subsections.

3.16.5.1 Regional Climate

The proposed DOF would be located in south Cameron Parish, Louisiana. All of Louisiana can be classified as having a warm, humid climate with hot summers (Köppen-Geiger climate classification Cfa) (NOAA 2016). Historic data from Lake Charles Regional Airport, which is near the proposed Delfin Onshore Facility, indicates a mean daily temperature ranging from 83°F in August to 51.8°F in January, with mean daily highs ranging up to 91.9°F in August, and mean daily lows ranging down to 42.3°F in January. Mean annual precipitation is 57.5 inches, distributed relatively evenly throughout the year (Southern Regional Climate Center 2016).

The entire Gulf of Mexico and its coastal areas are subject to tropical storms and hurricanes, which are most likely to occur between late May and early November. On average, the proposed Project area will experience a tropical storm (sustained winds of at least 39 miles per hour, or 17 m/s) every 1 or 2 years, while a hurricane (sustained winds of at least 74 miles per hour, or 33 m/s) can be expected to cross the proposed Project area once every 4 to 5 years. A "major" hurricane rated as Category 3 or higher (sustained winds of at least 110 miles per hour, or 50 m/s) may occur about once every 25 years. At the proposed Port location, storms have the potential to produce significant waves that present a hazard to ocean-going vessels. Along coastal locations, heavy rains and wind-driven storm surges may cause local or widespread flooding.

3.16.5.2 Existing Ambient Air Quality

NAAQS were developed by the USEPA to protect public health (primary standards) and public welfare (secondary standards). Primary standards are based on observable human health responses and are set at levels that provide an adequate margin of safety for sensitive segments of the population. Secondary standards are intended to protect welfare interests such as structures, vegetation, and livestock. Air dispersion modeling is used by proposed new sources to demonstrate compliance with both the primary or secondary standards. States use ambient air monitoring systems to determine whether AQCRs are meeting the NAAQS. Areas meeting the NAAQS are termed attainment areas, and areas not meeting the NAAQS are termed nonattainment areas. Areas that have insufficient data to make a determination of attainment/nonattainment are unclassified or are not designated, but are treated as being attainment areas for permitting purposes. The designation of an area is made on a pollutant-specific basis.

Cameron Parish has been designated as attainment or unclassifiable for all NAAQS.

When air pollutant dispersion modeling is conducted to predict air quality impacts from a proposed source, the existing background concentrations must also be considered. Table 3.16-1 presents monitoring data collected by nearby ambient monitoring stations during the 3-year period of 2011 through 2013. For each pollutant, data were selected from the nearest available monitoring site to the proposed DOF. The selected monitoring sites are located in Westlake, Louisiana, approximately 41 miles northeast of the proposed DOF; Jefferson County, Texas, approximately 25 miles northwest of the proposed DOF site; Lake Charles, Louisiana, approximately 38 miles northeast of the proposed DOF site; and Lafayette, Louisiana, approximately 100 miles northeast of the proposed DOF site.

Table 3.16-1. Background Ambient Air Quality and Ambient Air Quality Standards

Air Pollutant	Averaging Period	Statistic	Monitor Values a/	Monitoring Site (Site ID)	Primary NAAQS b/
Sulfur Dioxide (SO_2)	1-hour	99th Percentile of daily 1-hour maximum averaged over 3 years	35 ppb	Westlake, LA (220190008)	75 ppb
	3-hour	Not to be exceeded more than once per year	0.037 ppm	Westlake, LA (220190008)	0.5 ppm
	24-hour c/	Not to be exceeded more than once per year	0.019 ppm	Westlake, LA (220190008)	0.14 ppm
	Annual c/	Annual mean	0.004 ppm	Westlake, LA (220190008)	0.03 ppm
Carbon Monoxide (CO)	1-hour	Not to be exceeded more than once per year	0.7 ppm	Jefferson Co., TX (482451035)	35 ppm
	8-hour		0.6 ppm	Jefferson Co. TX (482451035)	9 ppm
Nitrogen Dioxide (NO_2)	1-hour	98th percentile averaged over 3 years	29 ppb	Westlake, LA (220190008)	100 ppb
	Annual	Annual mean	5.2 ppb	Westlake, LA (220190008)	53 ppb

Table 3.16-1. Background Ambient Air Quality and Ambient Air Quality Standards (continued)

Air Pollutant	Averaging Period	Statistic	Monitor Values a/	Monitoring Site (Site ID)	Primary NAAQS b/
Ozone (O_3)	8-hour	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years	65 ppb	Westlake, LA (220190008)	70 ppb
Particulate Matter (PM_{10})	24-hour	Not to be exceeded more than once per year on average over 3 years	77 μg/m^3 d/	Lafayette, LA (220550007)	150 μg/m^3
Particulate Matter ($PM_{2.5}$)	24-hour	98th percentile averaged over 3 years	17.8 μg/m^3	Lake Charles, LA (220190010)	35 μg/m^3
	Annual	Annual mean averaged over 3 years	7.9 μg/m^3	Lake Charles, LA (220190010)	12 μg/m^3
Lead (Pb)	Rolling 3-month	Not to be exceeded	e/	–	0.15 μg/m^3

a/ Monitor value shown matches the statistic of the NAAQS. Three-year averages are formed from 2011 to 2013 data. For CO, value shown is maximum second highest occurring in the 2011 to 2013 period. For NO_2 annual, value shown is highest annual mean from the period 2011 to 2013.

b/ Secondary standards are promulgated for some pollutants and are generally the same as or less stringent than primary standards. The revised ozone NAAQS (70 ppb) was signed by the USEPA Administrator on October 1, 2015 and will be effective 60 days after publication of the final rule in the Federal Register. Publication date is unknown at this time.

c/ The 24-hour and annual SO_2 standards were revoked in 2010. However, these standards remain in effect until one year after an area is designated for the 1-hour SO_2 standard.

d/ Value shown is maximum 2nd high from 2010 to 2012 data. Monitoring for PM_{10} 24-hour is not performed in south-western Louisiana. Closest monitoring site is Lafayette, Louisiana.

e/ Monitoring for lead is not performed in south-western Louisiana. Closest historical monitoring site is in Beaumont, Texas. Historical data at that location have shown compliance with the NAAQS.

Key:

ppb = part per billion; ppm = part per million; μg/m^3 = microgram per cubic meter

3.16.5.3 Greenhouse Gases

Solar radiation is primarily responsible for the Earth's climate system. Earth's temperature has been relatively constant over many centuries. Therefore, the incoming solar energy has been nearly in balance with outgoing radiation. Of the incoming solar shortwave radiation, about half is absorbed by the Earth's surface. The fraction of this radiation reflected back to space by gases and aerosols, clouds, and by the Earth's surface is approximately 30 percent, and about 20 percent is absorbed in the atmosphere. Based on the temperature of the Earth's surface, the majority of the outgoing energy flux from the Earth is in the infrared part of the spectrum. The longwave radiation (also referred to as infrared radiation) emitted from the Earth's surface is largely absorbed by certain atmospheric constituents—water vapor, CO_2, CH_4, N_2O, and other GHGs. The downward directed component of this longwave radiation adds heat to the lower layers of the atmosphere and to the Earth's surface. This is the so-called greenhouse effect.

The most important GHGs globally are CO_2, CH_4, and N_2O and these are the key GHGs potentially emitted by as well as potentially offset by the proposed Port. The increase in GHGs in the atmosphere from human-made or anthropogenic sources since the beginning of industrialization correlates with an increase in global average temperature.

The increasing trend in GHG concentrations and the potential effect of this change in atmospheric GHG concentrations on global climate has been studied extensively and is reported by the IPCC. The IPCC was set up in 1988 by the World Meteorological Organization and the United Nations Environment Programme to provide governments with a view of the state of knowledge about the science of climate change, potential impacts, and options for adaptation and mitigation through assessments of the most recent information published in the scientific, technical and socio-economic literature worldwide. The IPCC has released a series of reports over the past 15 years, with the latest being the Fifth Assessment Report (IPCC 2013). While the first IPCC assessment depended primarily on observed changes in surface temperature and climate model analyses, more recent assessments include multiple lines of evidence for climate change. The Fifth Assessment Report states,

> *there is incontrovertible evidence from in situ observations and ice core records that the atmospheric concentrations of GHGs such as CO_2, CH_4, and N_2O have increased substantially over the last 200 years. In addition, instrumental observations show that land and sea surface temperatures have increased over the last 100 years. Satellites allow a much broader spatial distribution of measurements, especially over the last 30 years. For the upper ocean temperature the observations indicate that the temperature has increased since at least 1950. Observations from satellites and in situ measurements suggest reductions in glaciers, Arctic sea ice and ice sheets. In addition, analyses based on measurements of the radiative budget and ocean heat content suggest a small imbalance. These observations, all published in peer-reviewed journals, made by diverse measurement groups in multiple countries using different technologies, investigating various climate-relevant types of data, uncertainties and processes, offer a wide range of evidence on the broad extent of the changing climate throughout our planet.*

Climate change is a global issue with all regions contributing anthropogenic GHG emissions and being impacted by climate change to various degrees. The IPCC has reported that a wide range of environmental effects could result from increasing concentrations of GHGs in the atmosphere. These may include increases in sea level and changes in weather patterns resulting in changes in temperature and moisture availability on a regional basis. These weather changes can then cascade to changes in biological communities both on land and in the ocean.

Locally, the Southern Climate Impacts Planning Program reports that the following impacts of climate change have already been observed in Louisiana (SCIPP 2014):

- Increasing temperatures have resulted in more frequent long-lasting heat waves, and since 1970, there are on average 10 to 20 fewer freezing days per year in Louisiana, encouraging the spread of mosquito-borne illnesses.
- Due to a combination of land subsidence and sea level rise, Louisiana has lost 1,900 square miles of coastal land in the past century.
- Also due to subsidence, sea level rise in the past century has been higher than the global average along Louisiana's coast, with Grand Isle experiencing 36 inches of sea level rise, versus a global average of 8 inches.
- Average annual precipitation in the region has increased by 20 to 30 percent in the past century, and a higher proportion of total rainfall is occurring during intense storms, increasing the likelihood of flash flooding.

GHG Regulations

The proposed DOF would not exceed the PSD major source threshold for emissions of criteria pollutants, and is therefore not required to obtain a PSD air permit. Major PSD sources must apply BACT to their potential GHG emissions, if such emissions exceed 75,000 tons per year. As a non-PSD source, the proposed DOF is not required to evaluate GHG BACT as part of its air permit application.

However, the proposed DOF would be subject to GHG reporting requirements under 40 CFR 98, which apply to owners and operators of certain facilities emitting greater than 25,000 metric tons per year of CO_2e. The proposed DOF would be included in the petroleum and natural gas systems category specified in 40 CFR 98, Subpart W. CO_2e emissions are calculated by multiply total mass emissions for each individual

GHG by its GWP, and then adding the results. For example, methane and nitrous oxide (N_2O), which after CO_2 are the two most common GHGs emitted by a facility of this type, have GWP factors of 25 times and 298 times that of CO_2, respectively.

3.17 Onshore Noise

This section is limited to discussion of onshore noise; offshore noise is addressed in Section 3.10.

3.17.1 Definition of the Resource

In the context of this analysis, noise is referring to airborne noise. The terms noise and sound are often used interchangeably. Physically there is no difference between these concepts, although it is an important distinction for the human listener. Noise is a class of sounds that are considered unwanted, and in some situations noise can adversely affect the health and well-being of individuals. Consequently, noise is not typically defined solely on the basis of physical sound parameters. Rather, it is defined operationally as audible acoustic energy that adversely affects, or can affect, the physiological and psychological well-being of people (Berglund and Lindvall 1995).

The standard unit of sound measurement is the decibel (dB). A dB is defined as the ratio between the measured sound pressure level (SPL) (in microPascals [µPa]) and a reference pressure (sound at a constant pressure, established by scientific standards). In air, that reference pressure is 20 µPa. The dB scale is a logarithmic measure used to quantify sound power or sound pressure that accounts for large variations in amplitude. A sound power level describes the acoustical energy of a sound and is independent of the medium in which the sound is traveling. As such, sound power levels are not measurable with a sound level meter, which only measures sound pressure levels. In air, the common reported value is A-weighted (dBA) to reflect how the human ear perceives sound. The A-weighting adjusts sound pressure levels below 1,000 Hz and above 4,000 Hz downward. The A-weighting scale uses specific weighting of sound pressure levels from about 31.5 Hz to 8.0 kHz for the purpose of determining the human response to sound. Since noise levels can vary over a given time period, they are quantified further using the equivalent sound level (L_{eq}) and day-night sound level (L_{dn}). The L_{eq} is an average of the time-varying sound energy for a specified time period. The L_{dn} is an average of the time-varying sound energy for one 24-hour period, with a 10-dB addition to the sound energy for the time period between 10 p.m. and 7 a.m. For reference purposes, typical noise levels in air and airborne sounds are presented in Table 3.17-1.

3.17.2 Laws and Regulations

There are no Federal regulatory limits for noise beyond the environmental analysis required by the DWPA and NEPA; however, in 1974, the USEPA published Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety (USEPA 1974). This publication evaluates the effects of environmental noise with respect to health and safety. The document provides information for State and local governments to use in developing their own ambient noise standards. The USEPA has determined that in order to protect the public from activity interference and annoyance outdoors in residential areas, noise levels should not exceed an L_{dn} of 55 dBA. The USEPA considers an L_{dn} of 55 dBA to be the maximum sound level that will not adversely affect public health and welfare by interfering with speech or other activities in outdoor areas.

There are no state or local ambient noise regulations applicable to the proposed DOF.

Table 3.17-1. A-Weighted Sound Levels for Some Common Airborne Sounds A-Weighted Level (dBA)

Sound Source	dBA	Perception/Response
	150	
Carrier Deck Jet Operation	140	
	130	Painfully Loud Limit
Jet Takeoff (200 feet) Discotheque Auto Horn (3 feet)	120	
Riveting Machine	110	
Jet Takeoff (2,000 feet) shout (0.5 feet)	100	
N.Y. Subway Station Heavy Truck (50 feet)	90	Very Annoying Hearing Damage (8 hours, continuous exposure)
Pneumatic Drill (50 feet)	80	Annoying
Freight Train (50 feet) Freeway Traffic (50 feet)	70	Telephone Use Difficult Intrusive
Air Conditioning Unit (20 feet)	60	
Light Auto Traffic (50 feet)	50	Quiet
Living Room Bedroom	40	
Library Soft Whisper (15 feet)	30	Very Quiet
Broadcasting Studio	20	
	10	Just Audible Threshold of Hearing
	0	
Source: NYDEC (2001)		

3.17.3 Required Permits

No specific Federal or State permits regarding noise are required.

3.17.4 Existing Threats

The onshore acoustic environment is currently impacted by a variety of sources. Existing sources of noise in the vicinity of the proposed DOF include wind in vegetation, industrial sources (including the adjacent Transco site), as well as commercial and private traffic along the Gulf Beach Highway.

3.17.5 Existing Conditions

An ambient sound survey was conducted on January 13, 2015, to establish preconstruction existing conditions in the vicinity of the proposed DOF. The site is located in a mixed industrial and rural area with no residents within 0.5 mile of the site. The nearest noise sensitive area (NSA) is a residence at 5870 Gulf Beach Highway (NSA #2), located 3,380 feet west of the center of the proposed compressor site. NSAs include homes, schools, churches, or any location where people reside or gather. The noise sources noted in the area during the study included wind, industrial facilities, and vehicular traffic on local roads. Sound level measurements were collected at the NSAs, and results are given in Table 3.17-2.

Table 3.17-2. Ambient Sound Level Survey Results

NSA	Location	Distance from NSA to Site Center (feet)/Direction	Day/Night	Measured Sound Level, L_{eq} (dBA)	Calculated L_{dn} (dBA)	Observations
1	1265 Cameron Meadows Oil Field Road	4,765/West	day	45.8	52.2 a/	Industrial noise audible west of location. Gulf Beach Highway traffic audible. Wind speed increased at night.
			night	53.0		
2	5870 Gulf Beach Highway	3,380/East	day	63.8	65.3	Gulf Beach Highway traffic audible. PSI Facility audible.
			night	57.1		
3	Long Beach Road at Gulf of Mexico	5,460/Northwest	day	49.4	55.8 b/	Industrial sources barely audible. Wind speed increased at night.
			night	56.1		

Notes:
a/ Calculated based on both night- and day-time level 45.8 to negate the effect of wind.
b/ Calculated based on both night- and day-time level 45.8 to negate the effect of wind.

3.18 Socioeconomics

As required by NEPA, this final EIS includes an analysis of the impact on human health and welfare, including socioeconomic impacts and environmental justice. The following sections provide demographic data for the proposed Project area.

3.18.1 Definition of the Resource

Socioeconomic resources represent the people and households, community diversity and cohesion, permanent and temporary living arrangements, economic base and structure, employment resources and quality of the labor force, government institutions, and public infrastructure and provision of municipal services within a community. Socioeconomics also includes natural resource assets and endowments that influence the quality of life and attract visitors and economic development of the area. The unique combination of land, labor capital, and technology represent the fabric that defines a community.

The socioeconomic impact area is variable, depending on the social or economic factors under consideration. This section is focused on economic conditions for the four parishes and counties along the Gulf Coast that are closest to the sites of the proposed Project's offshore facilities, including Cameron and Calcasieu parishes in Louisiana and Orange and Jefferson counties in Texas. Existing socioeconomic conditions for the cities of Lake Charles and Sulphur, Louisiana, and Port Arthur, Texas, are provided as appropriate. Ports and heliports that would likely be used when transporting workers and equipment offshore are located in this area (Figure 3.18-1). These communities are closely tied to the oil and gas industry, both onshore and offshore. This area has fairly developed support services for offshore industries and is likely to experience some impacts, including direct/indirect economic benefits from construction and operation of the proposed Port.

3.18.2 Laws and Regulations

In addition to the DWPA and NEPA, the following laws and regulations apply to socioeconomics (see Section 1.5 for a detailed discussion on applicable laws and regulations pertaining to the proposed Project):

- EO 12989, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, and associated CEQ and USEPA guidance documents;
- Outer Continental Shelf Lands Act; and
- Cameron Parish Coastal Resource Management Plan.

3.18.3 Required Permits

There are no required permits regarding socioeconomic resources.

3.18.4 Existing Threats

The oil and gas industry is a component of the socioeconomic environment of the Project area. Housing is an important issue, and energy development and other sources of employment can result in lodging scarcity, resulting in increased housing costs. However, this threat is minimal, as the Project area has relatively high vacancy rates. Volatility in energy markets can lead to changes in labor demand. Also, extreme weather can cause considerable damage to structures in the Project area, negatively impacting investments made by both businesses and private individuals.

3.18.5 Existing Conditions – Offshore

This section is limited to a discussion of offshore socioeconomic resources including marine-based tourism and recreation, recreational fisheries and boating, commercial fisheries, marine commerce and shipping, and other offshore resources.

3.18.5.1 Marine-Based Tourism and Recreation

The proposed Port has the potential to impact marine tourism and recreation based on the fact that some level of increased activity can be anticipated in the coastal waters that comprise this Project area. It should be noted, however, that this area of the Gulf coast has very few appropriate ports to support such activity. The primary bases of operations for marine tourism in this region are located in the Mississippi delta, for example, Venice and Empire, Louisiana.

3.18.5.2 Recreational Fisheries and Boating

The proposed Port has the potential to impact recreational fishing and boating based on the fact that some level of increased activity can be anticipated in the coastal waters that comprise this Project area during construction. It should be noted, however that this area of the Gulf coast has very few appropriate ports to support such activity. The primary bases of operations for recreational fishing and boating in this region are located in the Mississippi delta, for example, Venice and Empire, Louisiana.

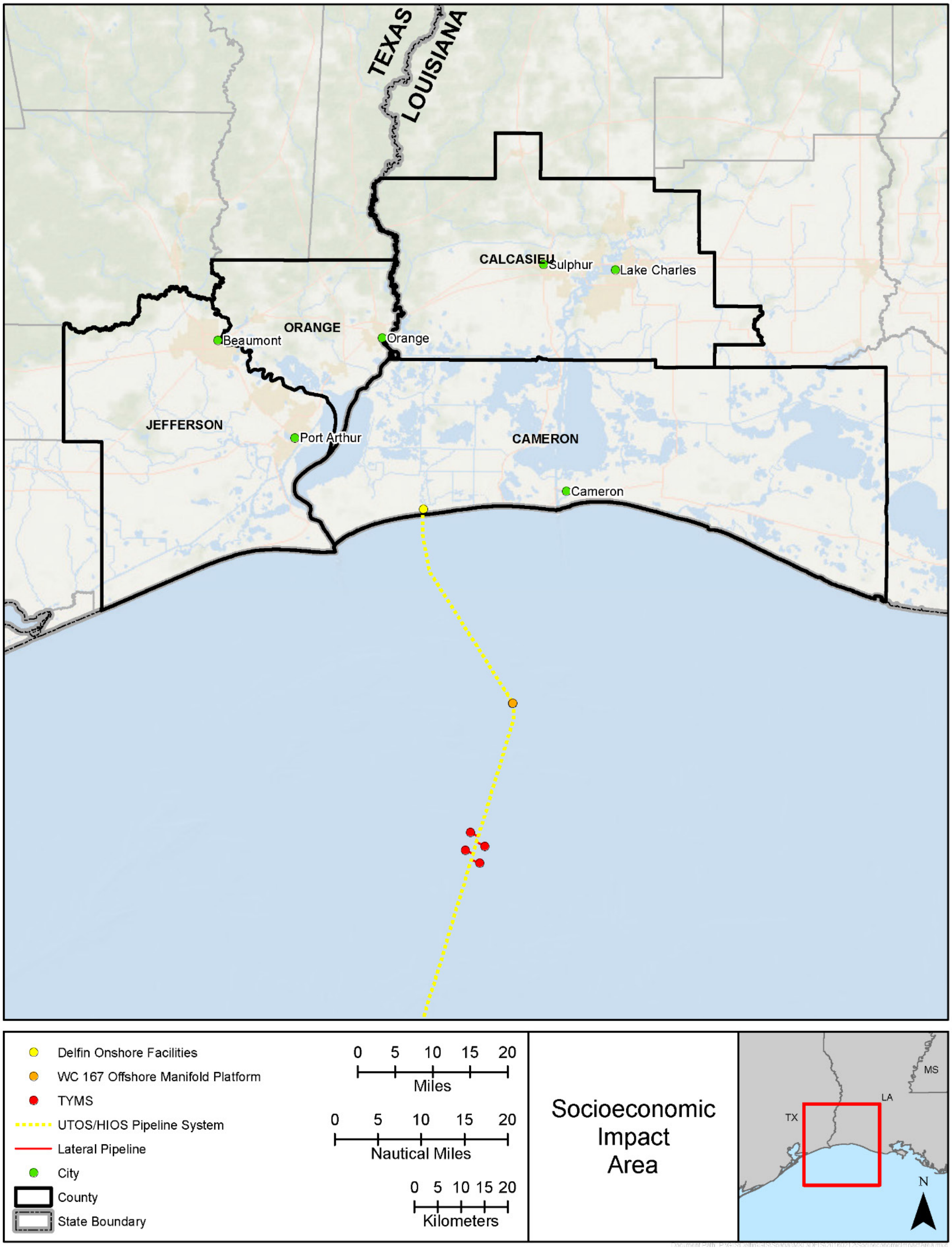


Figure 3.18-1. Socioeconomic Impact Area

3.18.5.3 Commercial Fisheries

A summary of the employment associated with the commercial fishing industry in the proposed Project area, including the number of commercial fishing establishments and their annual revenue, is provided in Table 3.18-1. Commercial fisheries landing data for the Gulf of Mexico and Louisiana are provided in Section 3.3.12.2. Collected from the U.S. Census Bureau, the data in Table 3.18-1 are statistics associated with the commercial fishing industry code "1141," defined by the North American Industry Classification as follows: "comprises establishments primarily engaged in the commercial catching or taking of finfish, shellfish, or miscellaneous marine products from a natural habitat, such as the catching of bluefish, eels, salmon, tuna, clams, crabs, lobsters, mussels, oysters, shrimp, frogs, sea urchins, and turtles" (U.S. Census Bureau 2015a). The commercial fishing establishments are categorized in two ways. Nonemployer establishments include sole-proprietorships, partnerships between two or more people, and incorporated business with no employees (only owners or partners). If the commercial fishing establishment is set up as a business with paid employees, then it is classified and tracked separately.

Table 3.18-1. Commercial Fishing Industry Employment Statistics a/

Project Area	Nonemployer Establishments		Paid Employee Establishments		
	Number of Establishments b/	Receipts ($1,000)	Number of Establishments c/	Paid Employees	Annual Payroll ($1,000)
Louisiana	6,334	375,541	62	100-249	3,122
Cameron Parish, LA	144	8,281	0	0	0
Calcasieu Parish, LA	120	3,235	0	0	0
Texas	3,927	257,342	65	250-499	4,974
Orange County, TX	54	2,480	0	0	0
Jefferson County, TX	378	31,765	3	0-19	d/

Notes:

a/ Nonemployer statistics originate from tax return information of the Internal Revenue Service. The data are subject to nonsampling error such as errors of self-classification by industry on tax forms, as well as errors of response, nonreporting and coverage. Values provided by each firm are slightly modified to protect the respondent's confidentiality.

b/ Nonemployer establishments include all firms with no paid employees or payroll with receipts of $1,000 or more and are subject to Federal income tax.

c/ Paid employee establishments include all operating establishments with one or more paid employees.

d/ Withheld to avoid disclosing data for individual companies; data are included in higher level totals.

Source: U.S. Census Bureau (2015b)

The majority of commercial fishing establishments in the impact area are nonemployer establishments, and most are likely self-employed fishermen, although some may be partnerships or incorporated businesses with no employees. Similarly, the majority of the commercial fishing establishments in the states are nonemployer establishments. In total, there are approximately 696 nonemployer establishments in the impact area, which is approximately 6.9 percent of the nonemployer establishments in Texas and Louisiana. The revenues generated by those 696 nonemployer establishments, approximately $45.8 million, are about 7.2 percent of the total revenues generated by nonemployer establishments in Texas and Louisiana in 2013. Only Jefferson County was recorded as having commercial fishing paid employee establishments. Given the small number of paid employee fishing establishments registered in Jefferson County, the total payroll at those establishments was withheld to avoid disclosing data for individual companies.

In the immediate Project area, there are few large commercial fishing ports. The only noteworthy commercial fishing port in the general area is Galveston, Texas, where $69 million of catch was landed in 2014, making it the 12th largest in the United States that year. Based on satellite imagery searches and the in-person reconnaissance of the NOEP (2015) team, there are a few small clusters of trawlers in places such as Cameron, Louisiana, and in and around Lake Sabine but there is not an organized commercial fleet on this area of coastline aside from Galveston, Texas.

3.18.5.4 Marine Commerce and Shipping

The commercial shipping activities that could potentially be impacted by construction tasks associated with completing the proposed Port would most likely be vessels transiting in and out of the existing petroleum facilities or into or out of Cameron, Louisiana, Sabine Pass, Louisiana, or, to a lesser degree, Galveston, Texas. This area of the Gulf experiences high volumes of petroleum industry support traffic each day of the year. Be it floating rig transits, tanker traffic, or support vessels, an offshore ship is nearly always in transit in the proposed Project area. Figure 3.18-2 shows many of the possible routes around the proposed Port using the many existing channels and fairways.

3.18.5.5 Other Offshore Resources

Other offshore resources include mineral resources such as oil, gas, sulphur, geopressured-geothermal and associated resources, and all other minerals which are authorized by an Act of Congress to be produced from public lands as defined in the Outer Continental Shelf Lands Act of 1953. In the vicinity of the proposed Project, offshore extraction of resources including oil and gas is prolific. As stated in Section 3.7.5, Louisiana ranks only behind Texas with respect to gasoline refineries and production. BOEM and BSEE are primarily responsible for OCS management, both for mineral exploration and development, and renewable energy development. Both bureaus are part of the U.S. Department of the Interior. Other Federal agencies, including NOAA, USEPA, and the Office of Natural Resources Revenue, also have a role in regulating aspects associated with development on the OCS. State agencies, including Louisiana and Texas, are also involved in management of offshore resources.

The petroleum resources located on this area of the Gulf of Mexico are vast and have been productive for nearly 60 years. In the era just after World War II through the 1950s, most Gulf of Mexico-based oil and gas exploration occurred within a mile or two of the coast. By the early 1980s when the United States established the EEZ, seismic survey technology had allowed searchers to locate reserves but the industry did not yet have the vessels or facilities to confirm the presence of the resource, much less extract it and get it to market. Also, as the water was deeper and deeper as the fields push farther offshore, it became impossible to have divers work near the seabed. This is why remotely operated vehicles became the key tools of the industry penetrating to depths that divers never could. Industry technology improved and investments and subsidies allowed the offshore crude oil production to exceed 25 percent of the U.S. total by 1999. The industry continued to grow and even in 2005, when storms destroyed 113 offshore platforms and severely damaged over 50 others, the industry continued on (BOEM n.d.).

Ancillary industries benefited from the burgeoning offshore mineral extraction industry as well. For example, the Gulf shipyards and fabricators actually benefited from the storms of 2005 because so many ships and facilities needed to be rebuilt. The value of this industry cannot be overstated when it comes to the socioeconomic development that it brings to the Gulf states, especially Louisiana and Texas.

As discussed in Section 3.7.5, there currently are no wind projects offshore of Louisiana, largely due to the cost of development.

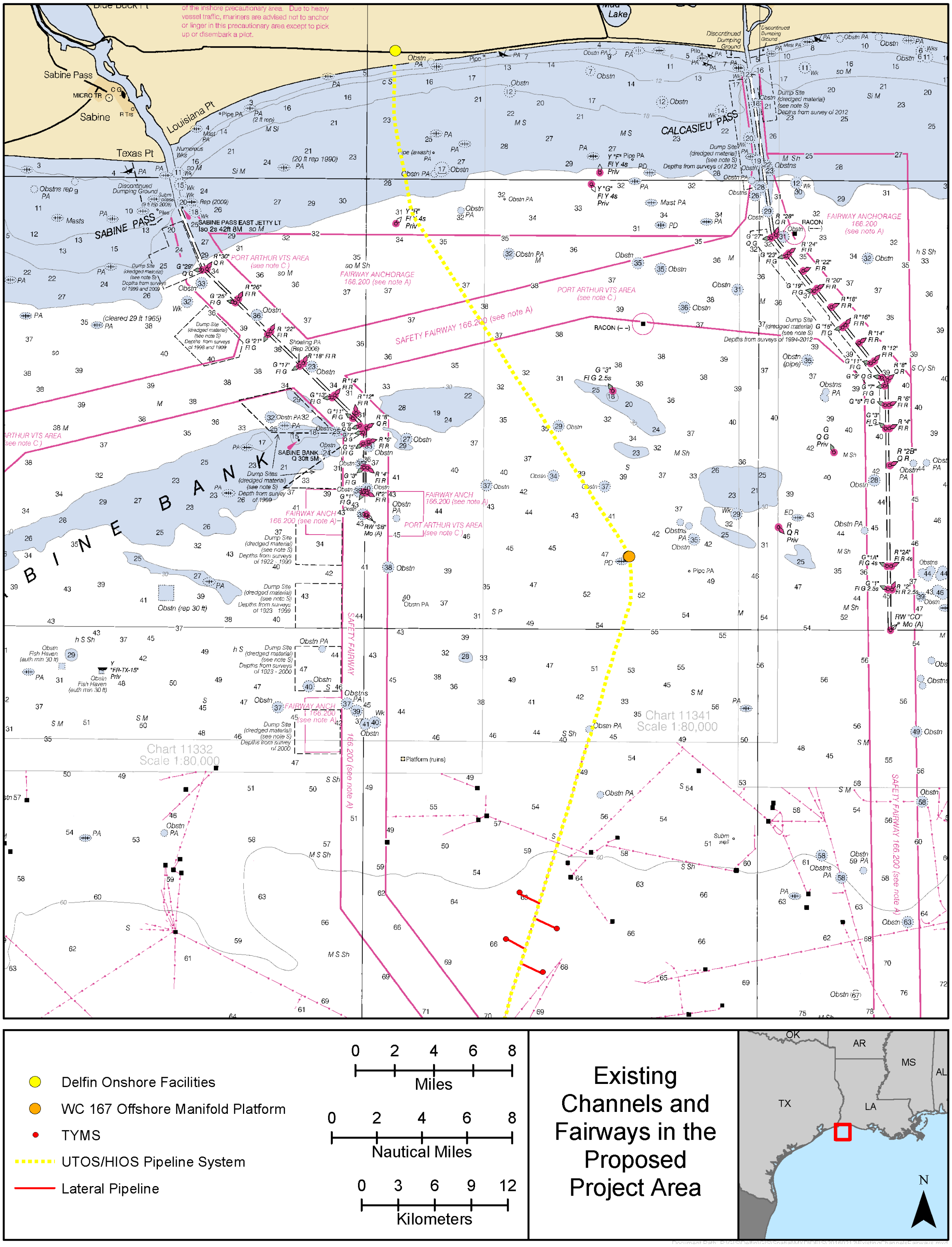


Figure 3.18-2. Existing Channels and Fairways in the Proposed Project Area

3.18.6 Existing Conditions – Onshore

This section is limited to discussion of onshore socioeconomic resources including population and demographics, housing, employment and income, land-based recreation and tourism, public services, and environmental justice.

3.18.6.1 Population and Demographics

Population statistics from 2010 and 2014 for the impact area jurisdictions and the states of Louisiana and Texas are provided in Table 3.18-2. From 2010 to 2014, Cameron Parish and Sulphur, Louisiana, are the only areas to experience negative growth.

Table 3.18-2. Population Summary (2010 to 2014)

Project Area	2010	2014	Annual Growth (%)
Louisiana	4,533,372	4,601,049	1.49
Cameron Parish, LA	6,839	6,713	-1.84
Calcasieu Parish, LA	192,768	194,943	1.13
Lake Charles, LA (Calcasieu Parish)	71,993	73,503	2.10
Sulphur, LA (Calcasieu Parish)	20,410	20,275	-0.66
Texas	25,145,561	26,092,033	3.76
Orange County, TX	81,837	82,737	1.10
Jefferson County, TX	252,273	252,466	0.08
Port Arthur, TX (Jefferson County)	53,818	54,685	1.61
Sources: U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. DP05 - ACS Demographic and Housing Estimates; U.S. Census Bureau. 2010. Decennial Census. 2010 Demographic Profile Data - DP-1 - Profile of General Population and Housing Characteristics: 2010.			

3.18.6.2 Housing

A summary of housing conditions in the impact area is provided in Table 3.18-3.

Table 3.18-3. Existing Housing Conditions, 2010 to 2014 Five-Year American Community Survey Estimates

Project Area	Total Housing Units	Total Vacant Units	Homeowner Vacancy Rate (%)	Rental Vacancy Rate (%)
Louisiana	1,988,460	269,584	1.9	8.1
Cameron Parish, LA	3,621	1,044	3.7	11.3
Calcasieu Parish, LA	84,013	9,256	1.8	9.5
Texas	10,187,189	1,173,607	1.8	8.5
Orange County, TX	35,750	4,377	2.4	11.6
Jefferson County, TX	106,178	13,407	1.9	10.6
Sources: U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. DP04 – Selected Housing Characteristics.				

The inventory of hotels/motels and recreational vehicle (RV) parks in Table 3.18-4 indicates the amount of readily available temporary housing stock within the proximity of the proposed Port, in addition to the vacancy rates depicted in Table 3.18-3.

Table 3.18-4. Hotels/Motels and RV Parks in the Proposed Project Area

Project Area	Hotels/Motels	RV Parks	RV Park Spaces
Cameron Parish, LA	1	16	--
Sulphur, LA (Calcasieu Parish)	20	4	365
Lake Charles, LA (Calcasieu Parish)	31	4	155
Port Arthur, TX (Jefferson County)	9	5	--
Total	61	29	520 a/

Notes:
a/ Total number of park spaces is greater than the number provided; however, information on number of RV park spaces in Cameron Parish, LA, is not readily available to be included in this table.
Sources: Cameron Parish Tourist Commission (n.d.); Delfin LNG (2015); Greater Port Arthur Chamber of Commerce (n.d.); TripAdvisor (2016)

3.18.6.3 Employment and Income

A summary of labor force statistics is provided in Table 3.18-5, with occupation statistics provided in Table 3.18-6. As shown in Table 3.18-6, the proposed Project area has higher percentages of workers in the natural resources, construction, and maintenance category, and the production, transportation, material moving category, as compared with the states of Louisiana and Texas. Workers in these categories may have skillsets that are transferable to activities associated with the construction and operation of the proposed Port. Additional detail on employment in the recreational and commercial fishing industries is provided in Sections 3.18.5.2 and 3.18.5.3.

Table 3.18-5. Labor Force Statistics in the Proposed Project Area (2014)

Project Area	Civilian Labor Force a/	Unemployment Rate (%)	Median Household Income b/
Louisiana	3,610,029	8.7	$44,991
Cameron Parish, LA	5,255	6	$64,129
Calcasieu Parish, LA	151,705	8.9	$44,045
Texas	19,858,082	7.7	$52,576
Orange County, TX	199,470	10.2	$42,368
Jefferson County, TX	64,794	8.7	$48,766

a/ Civilian labor force is defined as employed civilians 16 years old and over and unemployed civilians 16 years old and over who were actively looking for work during the previous four weeks (Bureau of Labor Statistics 2015).
b/ Income is provided in 2014 Inflation-Adjusted Dollars.
Sources: U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. S2301 - Employment Status; U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. DP03 - Selected Economic Characteristics

Table 3.18-6. Occupations in the Proposed Project Area

Project Area	Management, Business, Science, and Arts a/	Service b/	Sales and Office c/	Natural Resources, Construction, and Maintenance d/	Production, Transportation, and Material Moving e/
Louisiana	31.9	19.2	24.2	12.2	12.5
Cameron Parish, LA	28.0	12.5	21.2	20.9	17.4
Calcasieu Parish, LA	29.5	21.2	22.9	13.1	13.4
Texas	34.9	17.8	24.6	10.9	11.8
Orange County, TX	28.2	15.8	24.6	15.1	16.3
Jefferson County, TX	28.5	20.6	23.5	13.1	14.4

Notes:

a/ Workers in management, business, science and arts include a variety of workers in management, business and financial operations, computer and engineering, architects, and life, physical and social science occupations, as well as education, legal, community service, arts, and media, and healthcare practitioners and technical occupations.

b/ Workers in service include a variety of workers in healthcare support, protective service, food preparation, building and ground cleaning, personal care, and service occupations.

c/ Workers in sales and office include a variety of workers in sales and office administrative support occupations.

d/ Workers in natural resources, construction, and maintenance include a variety of workers in farming, fishing, and forestry, construction and extraction, and installation, maintenance and repair occupations.

e/ Workers in production, transportation, and material moving include a variety of workers in production and transportation and material moving occupations.

Sources: U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. S2405 - Industry By Occupation for the Civilian Employed Population 16 Years and Over

3.18.6.4 Land-Based Recreation and Tourism

No national or state parks and forest or nature preserves are located near the proposed DOF. The nearest recreational facility is the Johnson Bayou Recreation Center, located 3.8 miles to the west of the proposed DOF. Five public beaches along the Gulf of Mexico are within 4 miles of the proposed DOF: Long Dun Beach (0.8 mile), Mae's Beach (1.5 miles), Little Florida Beach (2.0 miles), Gulf Breeze Beach (2.8 miles), and Constance Beach (3.6 miles). Other land-based attractions include eco-tours and other wildlife watching and exploration.

Although wildlife tourism is an important industry for Louisiana and the surrounding region, employing 489,256 people along the Gulf Coast and 82,797 in Louisiana, the proposed DOF is not located in an area associated with this industry; rather, this area is dominated by industrial activities, including other oil and gas facilities. A total of 45 jobs are associated with tourism in Cameron Parish, Louisiana which is less than ten percent of total employment in the area (Datu Research, LLC 2013).

Additional detail on land-based recreation resources near the proposed DOF is provided in Section 3.15.5.

3.18.6.5 Public Services

The public services that could potentially be impacted by activities associated with the proposed Project offshore facilities would be in communities closest to the proposed Project site. The closest public services would be most likely to respond to any incident associated with installation, operation, accident/upset, or decommissioning activities. Also, they would be most likely to experience effects from temporary workforce presence in the area. The public services inventory was limited to the available medical, safety, and school services in selected communities most likely to experience more than negligible effects on these services. The communities include Cameron Parish, Louisiana; Lake Charles, Louisiana; Sulphur, Louisiana; and Port Arthur, Texas (see Figure 3.18-2). Table 3.18-7 provides a summary of public services in the proposed Project area, including hospitals and beds, fire departments, law enforcement agencies, and schools and students.

Table 3.18-7. Public Services in the Proposed Project Area

Project Area	Hospitals (a/) Number of Beds	Fire Departments	Law Enforcement Agencies	Public Schools (b/) Number of Students
Cameron Parish, LA	1/25	6	1	4/1,283
Sulphur, LA (Calcasieu Parish, LA)	1/109	2	2	11/7,013
Lake Charles, LA (Calcasieu Parish, LA)	3/655	6	2	33/19,638
Port Arthur, TX (Jefferson County, TX)	2/451	7	2	14/9,002

Notes:

a/ Totals do not include long-term extended-care, psychiatric, rehabilitation, or labor delivery and women's services hospitals.

b/ Totals do not include schools for special education.

Sources: Delfin LNG (2015); Cameron Parish Police Jury (n.d.); CHRISTUS Hospital (n.d.); Louisiana Office of State Marshal (n.d.); Port Arthur Fire Department (n.d.); The Medical Center of Southeast Texas (n.d.)

3.18.6.6 Environmental Justice Analysis

According to the USEPA and CEQ guidance documents, a low-income population should be identified in an affected area when the percentage with incomes below the poverty level either exceeds 50 percent or is meaningfully greater than in the general population of the larger surrounding area (CEQ 1997; USEPA 1998). In addition, a minority population should be identified when 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 (CEQ 1997; USEPA 1998). For the purposes of environmental justice analyses, minority groups may be African American, American Indian, Asian American, Pacific Islander, some other race, two or more races, or ethnically Hispanic.

Table 3.18-8 provides the racial and ethnic percentages in the proposed Project area, as well as the percentages of persons with incomes below the poverty line.

As shown in Table 3.18-8, the cities of Lake Charles, Louisiana, and Port Arthur, Texas, have racial minority populations that exceed 50 percent of the total population and are meaningfully greater than the states of Louisiana and Texas overall; therefore, these cities could be considered environmental justice communities. Port Arthur also has a poverty rate that is meaningfully greater than Jefferson County, in which it is located, and the state of Texas overall. Percentage-wise, Jefferson County has a large racial minority population compared with Texas, but the percentage of racial minorities in Port Arthur is still higher. The other counties, parishes, and cities in the proposed Project area do not have racial or ethnic minorities or poverty rates that are meaningfully greater than the surrounding area. These include Calcasieu and Cameron parishes, Sulphur City, and Orange County.

Table 3.18-8. Race, Ethnicity, and Poverty Levels, 2010-2014 American Community Survey 5-Year Estimates

Community	White	Black or African American	American Indian and Alaska Native	Asian	Native Hawaiian and Other Pacific Islander	Some other Race	Hispanic or Latino (of a race)	Percent Individuals Below Poverty
Louisiana	**62.8**	**32.1**	**0.6**	**1.6**	**0.0**	**1.1**	**4.6**	**19.6**
Calcasieu Parish	71.0	23.0	0.4	1.2	0.0	0.4	2.8	17.2
Cameron Parish	96.5	3.1	0.0	0.0	0.0	0.0	2.1	8.3
Lake Charles	45.8	48.9	0.3	2.1	0.0	2.4	3.2	23.6
Sulphur	93.9	4.5	0.3	0.7	0.2	0.1	4.7	19.1
Texas	**74.7**	**11.9**	**0.5**	**4.1**	**0.1**	**6.4**	**38.2**	**17.7**
Jefferson County	57.6	33.5	0.3	3.6	0.0	3.1	18.1	21.3
Orange County	87.4	8.3	0.4	1.1	0.0	0.9	6.4	14.8
Port Arthur	48.9	37.4	0.4	6.9	0.0	4.2	31.1	30.4

Sources: U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. Selected Economics Characteristics; U.S. Census Bureau. 2010-2014 American Community Survey 5-Year Estimates. Demographics and Housing Estimates.

An analysis of the potential for environmental justice impacts is provided in Section 4.18.9 of this final EIS.

4.0 ENVIRONMENTAL CONSEQUENCES OF THE PROPOSED ACTION AND ACTION ALTERNATIVES

4.1 Introduction

As discussed in Section 3.1, this section of the final Environmental Impact Statement (EIS) is divided between environmental consequences of offshore facilities (Sections 4.2 through 4.10) and onshore facilities (Section 4.11 through 4.17). The socioeconomic environment is only addressed in Section 4.18. This distinction and organization of the document allows for more focused agency review at the Federal and State level.

Potential impacts on environmental resources may be long-term or short-term; negligible, minor, moderate, or major; adverse or beneficial; or direct or indirect. As used in this analysis, these characteristics are defined below.

Long-Term or Short-Term

These characteristics are determined on a case-by-case basis and do not refer to a rigid time period. In general, long-term impacts would occur either continually or periodically throughout the life of the proposed Project (e.g., operational air emissions), or the impacts of an activity would last for years after an activity occurred. Short-term impacts are those that would occur only during a specific phase of the proposed Project, such as during construction or installation activities. Although construction of proposed Project components would occur over a 4-year period, actual construction-related impacts for certain components would only last 3.5 to 7.5 months; these were considered short-term because the impacts would end at the time, or shortly after, construction activities ceased. The duration of most short-term impacts would be only a few hours or days (USCG and MARAD 2006a-c).

Negligible, Minor, Moderate, or Major

These relative terms are used to characterize the magnitude of an impact. Negligible impacts are generally those that might be perceptible, but are at the lower level of detection. A minor impact is slight, but detectable. Moderate impacts are those that are more perceptible, typically are more amenable to quantification or measurement, and may approach major thresholds. Major impacts are those that, in their context and due to their intensity (severity), have the potential to meet the thresholds for significance set forth in Council on Environmental Quality (CEQ) regulations.[22] Such impacts warrant heightened attention and examination for potential means for mitigation in order to fulfill the policies set forth in the National Environmental Policy Act (NEPA). Implementation of the mitigation measures identified in this final EIS would reduce the magnitude of any impact initially identified as major to minor (USCG and MARAD 2006a-c).

Adverse or Beneficial

An adverse impact would cause unfavorable or undesirable outcomes on the natural or human environment. A beneficial impact would cause positive outcomes on the natural or human environment. A single act might result in adverse impacts on one environmental resource and beneficial impacts on another resource. For example, sediment disturbance could expose benthic invertebrates to predation, which would adversely impact the benthic community, but would result in a beneficial impact on fish by increasing prey availability (USCG and MARAD 2006a-c).

Direct or Indirect

Direct impacts can be identified and assessed with more certainty than indirect impacts because they occur at the same time and the same place as the proposed Port Delfin LNG Project (Project). Direct impacts can be short-term or long-term. Indirect impacts are more difficult to identify and assess because

[22] 40 Code of Federal Regulations (CFR) 1508.27

they occur in the near and distant future and involve dynamic variables. Indirect impacts would not occur if it were not for the proposed Project (USCG and MARAD 2006a-b).

4.1.1 Evaluation Criteria

The evaluation criteria summarized in Table 4.1-1 provide a framework for establishing context and intensity. These evaluation criteria were developed by environmental professionals in the respective fields in coordination and consultation with stakeholder agencies. Although some evaluation criteria have been designated based on legal or regulatory limits or requirements, others are based on best professional judgment and best management practices. The evaluation criteria include both quantitative and qualitative analyses, as appropriate to each resource.

Table 4.1-1. Evaluation Criteria for Determining Environmental Consequences by Resource Area

Resource	Evaluation Criteria a/
Water Resources	• Violate a Federal, State, or local or Federally recognized international water quality criterion or waste discharge requirement (major) • Cause irreparable harm to human health, aquatic life, or beneficial uses of aquatic ecosystems (major) • Degrade marine, coastal, or terrestrial (lakes, rivers, wetlands, tidal environments) water quality (minor to major depending on extent of degradation) • Increase contaminant levels in the water column, sediment, or biota to levels shown to have potential to harm marine organisms, even if the levels do not exceed the formal water quality criteria (moderate)
Biological Resources T&E Species Essential Fish Habitat	• Violate a legal standard for protection of a species or its critical habitat (major) • Degrade the commercial, recreational, ecological, or scientific importance of a biological resource or its critical habitat (minor to major depending on extent of degradation) • Measurably change the population size (density) or change the distribution of an important species in the region (minor to major depending on extent of change) • Introduce new, invasive, or disruptive aquatic species in the proposed Project site (minor to major depending on extent of infestation) • Directly impacting nesting migratory birds, including raptors, protected under the MBTA (major) • Reduce quality and/or quantity of essential fish habitat (EFH) as defined by the Magnuson-Stevens Fishery Conservation and Management Act, causing adverse effects such as direct or indirect physical, chemical, or biological alterations of the waters or substrate and loss of or injury to benthic organisms, prey species, and their habitat, and other ecosystem components if such modifications reduce the quality and/or quantity of EFH (major)
Geological Resources	• Destruction of unique geological features (major) • Increased erosion potential (minor to moderate depending on extent of increase) • Siting facilities to prevent recovery of mineral resources (minor to moderate) • Increased potential for geologic hazards, such as seismicity (minor to major depending on extent of increase) • Alteration of the lithology, stratigraphy, and geological structures that control the groundwater quality, distribution of aquifers and confining beds, and groundwater availability (minor to major depending on extent of alteration) • Alteration of the soil composition, structure, or function within the environment (minor to moderate depending on extent of alteration)

Table 4.1-1. Evaluation Criteria for Determining Environmental Consequences by Resource Area (continued)

Resource	Evaluation Criteria a/
Cultural Resources	• Potential to impact submerged cultural resources (minor to major depending on extent of adverse direct or indirect impact) • Irretrievable or irreversible damage to a prehistoric or historic property that is listed or eligible for listing on the National Register of Historic Places (NRHP) (major) • Adversely impact a prehistoric or historic property that is listed or eligible for listing on the NRHP (minor to major depending on extent of adverse impact) • Violate cultural resource standards by impacting resources that are of value to Native American culture and heritage (major) • Disturbs any human remains, including those interred outside of formal cemeteries (major)
Ocean and Land Use	• Alter the functional use of an area already used (minor to major depending on the current use) • Conflict with applicable planning and zoning (minor to moderate depending on extent of conflict) • Consistency with the State's Coastal Zone Management Plan (minor to moderate depending on extent of conflict) • Impacts on prime farmland or permanent loss/impairment of agricultural soils (moderate) • Impacts on existing residences or businesses (moderate to major)
Recreation	• Interference with access to coastal recreational shorelines or waterways (minor to moderate depending on extent of alteration) • Loss or displacement of an important recreational resource, such as impairment of recreational fishing activities and other water-dependent uses (minor to major depending on extent of alteration) • Degradation of recreational value (moderate)
Visual Resources	• Alter or impair a viewshed, scenic quality, or aesthetic value not consistent with applicable laws or regulations (minor to major depending on extent of alteration) • Create a new source of substantial light or glare that would, in the long term, adversely affect nighttime views from shoreline areas and adjacent water areas (minor to major depending on extent of alteration)
Transportation	• Long-term interference with access to transportation routes (minor to major) • Permanent decrease in Level of Service of key transportation arteries (minor to major) • Substantial increase in maritime traffic (minor to major) • Substantial increased risks of collisions or other mishaps (e.g., grounding) (minor to major depending on risk)
Air Quality	• Cause or contribute to a violation of any National Ambient Air Quality Standards (major) • Cause or contribute to a violation of a Class I or Class II increment (major) • Cause an adverse impact on air quality–related values in a Class I area (moderate to major) • Expose sensitive receptors to substantially increased pollutant concentrations (minor to major) • Increase emissions of criteria pollutants beyond limits allowed under Clean Air Act regulations (major) • Substantially increase the emissions of greenhouse gases (minor to moderate) • Creates objectionable odors affecting a substantial number of people (minor to moderate)

Table 4.1-1. Evaluation Criteria for Determining Environmental Consequences by Resource Area (continued)

Resource	Evaluation Criteria a/
Noise	• Substantial change in existing ambient noise levels on land (which s humans) or underwater (which could impact biological resources)(minor to moderate depending on change) • Violation of State or local noise ordinances, limits, or standards, or applicable land use compatibility guidelines (minor to moderate depending on violation)
Socioeconomics	• Substantial change to the local or regional economy, population, housing, infrastructure (schools, police, and fire services), social conditions, or employment (major)
Environmental Justice	• Disproportionate environmental health or safety risk to children (minor to major depending on risk and scope of impact) • Disproportionate environmental, economic, social, or health impacts on minority or low-income populations (minor to major depending on risk and scope of impact)

Note:
a/ Impact characteristics (i.e., minor, moderate, or major) as discussed in the table above provide a framework for establishing context and intensity. The evaluation criteria include both quantitative and qualitative analyses, as appropriate to each resource.

4.1.2 Best Management Practices and Agency Recommendations Incorporated into the Applicant's Proposed Action

Delfin LNG LLC (Delfin LNG) has identified best management practices (BMPs) for the construction and operation of the proposed Project. Delfin LNG has committed to implementing these measures to comply with Federal, State, and local requirements for permits, and to reduce potentially adverse environmental impacts if a license is issued for the proposed Project. BMPs are listed below and also identified in each resource section. Analyses of impact have factored in the commitments made by Delfin LNG to adhere to these BMPs and agency recommendations. If a license is issued:

- **BMP-1:** The proposed Project will be designed, constructed, tested, operated, and maintained to conform or exceed the requirements of applicable Federal, State, and local regulations.
- **BMP-2:** All Project-related activities will comply with Federal regulations to control the discharge of operational wastes such as bilge and ballast waters, trash and debris, and sanitary and domestic waste generated from vessels associated with the proposed Project.
- **BMP-3:** Delfin LNG will adhere to the Project-specific plans as well as other Federal and State permit requirements including the U.S. Army Corps of Engineers (USACE) Nationwide Permit 12.
- **BMP-4:** Prior to construction and operation, Delfin LNG will prepare and submit for approval a construction and operation Spill Prevention, Control, and Countermeasure (SPCC) Plan and Facility Response Plan (FRP) detailing emergency procedures for addressing accidental releases and spills during construction and releases.
- **BMP-5:** All construction vessels will operate in accordance with SPCC plans. All vessels will have spill containment kits and spill response plans for use in the event of a release. Typically, a spill response kit for a vessel other than an oil carrier must be capable of cleaning up an on-deck spill of a half-barrel or less.
- **BMP-6:** Delfin LNG will provide a hydrostatic test plan for approval by the U.S. Coast Guard (USCG) prior to any hydrostatic testing of pipelines. Delfin LNG does not currently plan on using a dye as part of hydrostatic testing; however, if subsequent design work should call for the use of a dye as part of hydrostatic testing, Delfin LNG will use a U.S. Environmental Protection Agency (USEPA)-approved dye.

- **BMP-7:** Delfin LNG will test the discharge water from the hydrostatic testing of the U-T Offshore System (UTOS) and High Island Offshore System (HIOS) pipeline systems for the presence of hydrocarbons, including the use of the USEPA's "visible sheen test." Delfin LNG will filter the hydrostatic discharge water sufficiently in order to meet the requirements of the general permit governing hydrostatic testing operations in the Gulf of Mexico.
- **BMP-8:** Delfin LNG will design the floating liquefied natural gas vessels (FLNGV) such that equipment on the main deck with the potential to release hydrocarbons is installed above drain/drip pains or within contained areas that will collect rainwater, wash water, and other fluids, which will be pumped or gravity drained to slop tanks.
- **BMP-9:** Delfin LNG will use the first-flush principal for rainwater collection and treatment.
- **BMP-10:** While ambient levels of contaminants were found to be low and the potential for introduction of toxic substances into the water column appear negligible, increases in turbidity may be measurable and require monitoring to ensure compliance with marine water standards. These standards will be established as part of the permitting process.
- **BMP-11:** A turbidity/suspended sediment monitoring program may be implemented to provide data on ambient bed load contribution to the water column during piling installation. This program will be analogous with what is required for offshore oil and gas exploration and production in the Gulf of Mexico.
- **BMP-12:** Delfin LNG will acquire the appropriate individual or project-based National Pollutant Discharge Elimination System (NPDES) permits for the continuous and intermittent discharges for the various on-board service systems. The NPDES permit will be administered by the USEPA for Federal waters and will require periodic monitoring for compliance under the Clean Water Act (CWA). The NPDES permits will establish set standards for individual chemical constituents in effluent discharges based on receiving water resource value and quality and established numerical water quality criteria. Continuous discharges will include sanitary, reverse osmosis, bilge, and ballast water from the four FLNVGs. In addition to these permanent discharges, intermittent discharges will also require monitoring as part of the NPDES permit. Similar discharges from the calling liquefied natural gas carriers (LNGC) at the proposed Port will also occur. Compliance monitoring of individual constituents in the discharges will vary and methods for monitoring may include inline electronic monitoring or direct effluent sampling for laboratory analysis. Compliance will be reported based on frequency of monitoring and established regulatory requirements as part of required discharge monitoring reporting in the NPDES permit. All associated discharges from the FLNGVs and LNGCs will be managed under the NPDES permit. Frequency of reporting and compliance will be required as part of the permitting reporting process. Unique or variable effluents may require whole effluent toxicity testing (WET) to determine compliance for mixed constituent effluents. Additional BMPs may be established for monitoring and sampling frequency for NPDES compliance monitoring for the FLNGVs.
- **BMP-13:** LNGCs calling on the proposed Port will be required to use approved equipment and follow and maintain records for ballast water and operational discharges (e.g., bilge, sanitary discharges) that are compliant with International Convention for the Prevention of Pollution from Ships (MARPOL) and USCG standards. LNGCs operating fully within Federal waters will be required to operate under a Vessel General Permit. Inspections will require review of onboard records for assessing compliance.
- **BMP-14:** Delfin LNG will institute impact minimization and mitigation measures throughout the course of the proposed Project. Delfin LNG will implement mitigations such as, but not limited to, use of lowest noise-producing impact hammer available, use of a cofferdam system (including the introduction of bubbles within the annulus between the pile and the cofferdam) to reduce the transmission of marine noise), use of the pile-driving soft start ramp-up procedures preceded by clearing the surrounding waters by a Protected Species Observer (PSO), and call for a suspension

of pile driving by the PSO should a protected species be observed in proximity to the active pile driving operation. Prior to operating at full capacity, Delfin LNG will implement a "soft start" with several initial hammer strikes at less than full capacity (i.e., approximately 40–60 percent energy levels) with no less than a 1-minute interval between each strike. PSOs will be present to conduct surveys before, during, and after all pile-driving activities to monitor for marine mammals within designated zones of influence (ZOI).

- **BMP-15:** The proposed Port will be designed and permitted under the Deepwater Port Act (DWPA), and thus will be required to meet all lighting stipulations as noted in 33 Code of Federal Regulations (CFR), Part 149. To this end, Delfin LNG will limit, to the greatest extent possible, the amount of total lighting used on the proposed Port to that required for safety and navigational concerns only. As such, to reduce the disruptive effects of lighting, all lighting at the proposed Port will be down-shielded to the greatest extent possible to reduce light dispersion to a minimum.
- **BMP-16:** Standard mitigations for marine mammal monitoring will be in place during construction, operation, and decommissioning.
- **BMP-17:** Delfin LNG will institute the procedures described in the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NOAA Fisheries) Southeast Region (2008) guidelines for "Vessel Strike Avoidance Measures and Reporting for Mariners", which call for vessels to maintain a vigilant watch for marine mammals and sea turtles to avoid striking protected species. Delfin LNG will adhere to the reporting procedures related to injured or dead protected species described in these guidelines.
- **BMP-18:** To prevent or mitigate potential noise impacts on marine mammals and sea turtle species, Delfin LNG will maintain minimal safe operating power at all times for vessels with dynamic positioning (DP) thrusters. Each of Delfin's FLNGVs will not engage thrusters if it is not required to do so. Additionally, if a marine mammal or sea turtle is detected within 500 meters (m) of a DP vessel, the responsible crew member will alert the vessel operators to minimize thruster power down to the absolute lowest safe operating levels. Other vessels in the immediate vicinity of the vessel that had an animal detected within 500 m will also be instructed to reduce to slow speed and minimum safe operating power consistent with the activities being performed.
- **BMP-19:** Delfin LNG will follow the recommendations of the U.S. Fish and Wildlife Service (USFWS) to take all measures possible to minimize the risk of gas flaring to migratory birds. Delfin LNG has agreed to avoid gas flaring at night, during low visibility (i.e. fog, storm events), and during peak migration (mid-March through April and September through October) to the maximum extent feasible. However, since flares are installed to accommodate process upset conditions as well as gas venting that might be required as a result of specific maintenance and safety procedures, random flaring events might occur at night, during low visibility, and/or peak migration periods.
- **BMP-20:** Delfin LNG will commit to utilizing the USFWS voluntary guidelines for communication tower design, siting, construction, and operation to the extent that these guidelines apply to the Delfin LNG project flaring tower. The planned tower design is a lattice structure without guy wires which is consistent with the USFWS recommendations. Should the top of the flare tower exceed 200 feet (ft) above sea level, the Federal Aviation Administration (FAA) will require pilot warning lights (flashing red or white strobe).
- **BMP-21:** Delfin LNG will follow USFWS recommendations to install cone-shaped mesh covers on the open vents of all the process vessels and storage tanks to minimize bird perching to the maximum extent feasible.

- **BMP-22:** Delfin LNG will consult regularly with the USFWS to determine the peak migration periods for the site of the Delfin LNG project.
- **BMP-23:** Delfin LNG will commit to monitoring for any bird mortality consistent with any recommendations from USFWS following each flaring event. The survey should be rigorous enough to detect any use by migratory birds of the offshore LNG facility and should encompass both the spring and fall migrations. Results of the fatality monitoring will be reported to the USFWS in order to assess any need for additional conservation measures that may be required to further reduce any bird fatalities.
- **BMP-24:** Delfin LNG commits to minimizing the area of subsea impact and duration of disturbance during installation and commissioning of the proposed Project. To minimize the area of subsea impact and duration of disturbance during decommissioning of the proposed Project, Delfin LNG will abandon subsea pipelines and other subsurface components more than 3 ft below mudline, and cut all bottom founded items such as driven pile and grouted pile anchors no shallower than 15 ft (approximately 5 m) below mudline to avoid exposure in the future due to storms, scouring, and other uses. Final site clearance will be verified by a trawling contractor to ensure compliance with Bureau of Ocean Energy Management (BOEM)/Bureau of Safety and Environmental Enforcement (BSEE) requirements and to ensure complete removal of infrastructure.
- **BMP-25:** If the proposed Project cannot avoid targets identified as potentially significant cultural resources, then further investigations will be required to determine if these targets represent potential historic properties. If the targets are identified as historic properties, an appropriate treatment plan will need to be developed and implemented prior to construction.
- **BMP-26:** Delfin LNG has developed an *Unanticipated Discoveries Plan* for the offshore components of the proposed Project (Appendix J). This plan will be reviewed by the Louisiana State Historic Preservation Office (SHPO), Texas SHPO, and BOEM. All proposed Project construction, operation, and decommissioning personnel shall be familiar with the plan and the steps that Delfin LNG has agreed to follow in the event of the discovery of a significant cultural resource including human remains.
- **BMP-27:** Delfin LNG commits to the zone of avoidance (ZA) with respect to the magnetic anomalies at the proposed Port site and the positive sonar contacts at the proposed West Cameron (WC) 167 bypass to avoid impacts on cultural resources during the installation and decommissioning phases of the proposed Port.
- **BMP-28:** Siting the proposed Port in a location with limited oil and gas activity and without unique fishing or recreational properties or significant sediment resources will minimize impacts on ocean uses and marine traffic.
- **BMP-29:** Siting the proposed Port more than 37 nautical miles from the Louisiana shore will prevent land-based viewers from having their viewshed impaired by the proposed Project.
- **BMP-30:** The Delfin LNG Port Operations Manual (Appendix K) outlines the procedures and mitigation measures that will be in place for the proposed Port, including establishment of Safety Zones, Areas to be Avoided (ATBA), and No Anchoring Areas (NAA) around each FLNGV (see Section 5), as well as other navigational aids.
- **BMP-31:** If required by the USCG, Delfin LNG will have selected construction and installation vessels make periodic very high frequency radio broadcasts advising nearby mariners of construction activities and the presence of any temporary safety zones.
- **BMP-32:** Delfin LNG will communicate with the USCG, USACE, and Federal and State pilots in the region (Lake Charles Pilots Association and Sabine Pilots) to provide information concerning proposed Project construction and installation activities.

- **BMP-33:** Notice to Mariners will be issued to provide wide notice of the temporary safety zone established during installation and commissioning of the proposed Project.
- **BMP-34:** Delfin LNG will minimize fugitive emissions through proper piping design, good work practices, and the implementation of a leak detection and repair (LDAR) program.
- **BMP-35:** Delfin LNG will minimize air emissions from marine vessels during construction through the operation and maintenance of vessels' engines in accordance with manufacturer recommendations. Delfin LNG will maintain and operate engines in accordance with recommended manufacturer operation and maintenance procedures.
- **BMP-36:** Delfin LNG will install turbines for use aboard the FLNGVs equipped with dry low nitrogen oxide (NO_x) burners to minimize emissions of NO_x.
- **BMP-37:** Delfin LNG will minimize emissions of all other pollutants from the turbines through firing with natural gas during routine operations, use of low sulfur fuel, and implementation of good combustion practices. Delfin LNG will be in compliance with USEPA and North American Emission Control Area requirements, as well as New Source Performance Standards Subpart IIII to minimize air emission from the emergency generator and fire pump engines aboard the proposed FLNGVs.
- **BMP-38:** Delfin LNG will minimize emissions from acid gas thermal oxidizers through the use of low NO_x burners, natural gas fuel, and good combustion practices.
- **BMP-39:** Delfin LNG will minimize emissions of all pollutants from the proposed FLNGVs' flares through the use of good combustion practices.
- **BMP-40:** Delfin LNG will limit greenhouse gases (GHG) and fugitive emissions through the use of best available control technology (BACT) controls, including waste heat recovery for the FLNGV power generation turbines, and implementation of an LDAR program. These required air emissions controls will be described in the proposed Project's Clean Air Act (CAA) permit issued by USEPA Region 6.
- **BMP-41:** Delfin LNG will minimize fugitive emissions through proper piping design, good work practices, and the implementation of a LDAR program. Delfin LNG will further limit GHG emissions through the use of BACT controls, including waste heat recovery for the FLNGV power generation turbines. These required air emissions controls will be described in the proposed Project's CAA permit issued by USEPA Region 6.
- **BMP-42:** All Project-related activities will comply with Federal regulations to control noise generated from vessels associated with the proposed Project.
- **BMP-43:** During construction, Delfin LNG will implement various procedure measures, including "soft starts." Prior to operating at full capacity, Delfin LNG will implement a "soft start" with several initial hammer strikes at less than full capacity (i.e., approximately 40–60 percent energy levels) with no less than a 1-minute interval between each strike.
- **BMP-44:** Delfin LNG will ensure that all equipment has sound control devices no less effective than those provided by the manufacturer.
- **BMP-45:** Standard mitigations for marine mammal monitoring and BMPs will be in place during construction, operation, and decommissioning. Any impacts resulting from Level A or Level B noise will be addressed with an Incidental Harassment Authorization from the Applicant.
- **BMP-46:** During construction and restoration, Delfin LNG will implement Delfin LNG's *Wetland and Waterbody Construction and Mitigation Procedures* (Procedures; Appendix F) to avoid, minimize, and mitigate potential impacts.
- **BMP-47:** During construction, Delfin LNG will implement its *Spill Prevention and Response Plan for Construction* (Appendix L) to prevent spills, leaks, and other releases of hazardous

materials that could impact onshore water quality. Delfin LNG will also implement its Stormwater Pollution Prevention Plan (SWPPP) (Appendix L) to minimize impacts on surface waters. Delfin LNG will conduct all work in accordance with a Louisiana Pollutant Discharge Elimination System permit for stormwater and industrial waste water and will meet all provisions as provided in Louisiana Administrative Code (LAC) 33:IX.2701, et seq.

- **BMP-48:** Delfin LNG will adhere to measures described in the Delfin LNG Procedures (Appendix F) and the Federal Energy Regulatory Commission's (FERC) *Upland Erosion Control Revegetation, and Maintenance Plan* (Plan; FERC 2013). Delfin LNG will work with the USACE and other State and local agencies during the permitting process to ensure wetlands are protected during construction and operation of the proposed Project.
- **BMP-49:** Delfin LNG will minimize impacts to onshore water resources, including wetlands, by locating the new community center on a parcel classified as "uplands" and away from wetland areas to the extent possible. If wetland impacts cannot be avoided, impacts to wetlands will be minimized and fully mitigated per the requirements of the Louisiana Department of Natural Resources (LDNR) and the USACE.
- **BMP-50:** Delfin LNG will minimize impacts to onshore biological resources, including threatened and endangered species, by locating the new community center away from areas that are designated as unique habitat to threatened or endangered species or vital habitat to migratory birds.
- **BMP-51:** Delfin LNG will conduct necessary monitoring, reseeding, fertilizing, or other measures needed to re-establish a vegetative cover equivalent to similar adjacent areas.
- **BMP-52:** Delfin LNG will use mechanical control of vegetation in the vicinity of waterbodies and will prohibit the use of herbicides within 100 ft of waterbodies.
- **BMP-53:** Delfin LNG will adhere to the Project-specific *Noxious Plant Control Plan* (Appendix M). Delfin LNG will handle Chinese tallow tree, a noxious weed, per this plan in order to mitigate the spread of this disease at the proposed Delfin Onshore Facility (DOF).
- **BMP-54:** Delfin LNG will conduct vegetation clearing and grading activities during the non-breeding season for most avian species (October-February) to the extent practicable. Should grading or clearing activities for the proposed DOF need to be conducted in other months, Delfin LNG will consult with the USFWS in advance to determine appropriate site-specific measures to minimize potential impacts on birds.
- **BMP-55:** To mitigate impacts on vegetation and potential wildlife habitat, Delfin LNG will restore and revegetate all areas not used for DOF operations following the guidelines and BMPs in the FERC Plan and Delfin LNG Procedures. Following construction, Delfin LNG will permanently stabilize disturbed areas within the construction site by covering with crushed rock (or the equivalent) or seeding with a grass that is compatible with the climate and easily maintained. If re-seeding of the construction work areas cannot be completed immediately following construction, Delfin LNG will mulch the disturbed areas and install appropriate erosion-control devices until final restoration and seeding can be completed. Roads and parking areas that may be disturbed by construction will be re-covered with crushed rock, concrete, or asphalt.
- **BMP-56:** Delfin LNG will take all measures possible to minimize the amount of total lighting used on the proposed terminal to that required for safety. Additionally, the amount of light will be minimized during the height of the trans-migratory period for bird species. To reduce the disruptive effects of lighting, all lighting at the terminal will be downshielded to keep the dispersion of light to a minimum. The shields will prevent the lights from shining skyward, instead directing the light to shine only on work areas. Shielded lighting has resulted in significant reductions in bird mortality (Evans Ogden 2002; Orr et al. 2013). A heliport is planned for the proposed Project's FLNGVs; Delfin LNG will install lighting on the heliport in

accordance with USFWS guidelines for aviation safety lights. These guidelines specify that only white or red strobe lights should be used at night and that these strobes should be minimal in number, intensity, and number of flashes.

- **BMP-57:** Delfin LNG will follow the recommendations of the FERC Plan (FERC 2013) and Procedures to mitigate localized slope failure hazards.
- **BMP-58:** Should blasting be required for construction of the proposed DOF, Delfin LNG will prepare and submit a blasting plan for FERC review and approval prior to conducting any blasting activities.
- **BMP-59:** Delfin LNG will adhere to the Project-specific FERC Plan (FERC 2013) and the Project-specific Procedures with regard to the use of appropriate erosion and sedimentation control measures during construction, until revegetation occurs. Following restoration and cleanup, the disturbed areas will be monitored to maintain erosion control structures and to repair any erosion.
- **BMP-60:** If the proposed Project cannot avoid cultural resources identified as potentially eligible for the National Register of Historic Places (NRHP), then further investigations will be required to determine if these qualify as historic properties. If the cultural resources are identified as historic properties, an appropriate treatment plan will need to be developed and implemented prior to construction.
- **BMP-61:** Delfin LNG has developed an *Unanticipated Discoveries Plan* for the proposed DOF (Appendix J). This plan was reviewed by the Maritime Administration (MARAD), FERC, and Louisiana SHPO. All proposed Project construction, operation, and decommissioning personnel shall be familiar with the plan and the steps that Delfin LNG has agreed to follow in the event of the discovery of a significant cultural resource including human remains.
- **BMP-62:** Delfin LNG commits to evaluation of the extent of contamination, required avoidance measures and the potential impact on existing cultural resources in developing response measures to any Project-related upsets/accidents involving limited heavy hydrocarbons and debris.
- **BMP-63:** Delfin LNG commits to implementation of a “no work area” as identified in its site avoidance plan for Site 16CM84.
- **BMP-64:** Delfin LNG commits to making reasonable efforts to avoid or minimize damage to cultural resources and to reporting the discovery of any previously unreported cultural resources to FERC and the Louisiana SHPO, as described above. Delfin LNG further commits to preliminary documentation of the cultural resource, avoidance of further damage, and cooperation with FERC and the Louisiana SHPO to develop appropriate plans regarding the discovery.
- **BMP-65:** In the event that human remains are discovered, Delfin LNG commits to stopping work and following the Louisiana State guidelines outlined in the applicable portions of the Unmarked Human Burial Sites Preservation Act (Louisiana Revised Statute [La. R.S.] 8:671–681) and the Louisiana Historic Cemetery Preservation Act (La. R.S. 25:931–943).
- **BMP-66:** Delfin LNG will coordinate with the Louisiana SHPO regarding the site selection process for the new community center. If recommended by the Louisiana SHPO, a Phase 1 Cultural Resource investigation will be conducted prior to final site selection to ensure no impacts to cultural resources. Delfin LNG will also implement its *Unanticipated Discoveries Plan* (Appendix J) should unknown cultural resources be discovered during construction of the community center.
- **BMP-67:** All Project-related activities will comply with Federal, State, and local regulations to control air emissions generated by construction and operation of the proposed DOF.
- **BMP-68:** Delfin LNG will implement the following measures to minimize impacts on noise receptors during construction:

- Perform construction during daytime hours when there is less sensitivity to sound;
- Locate stationary construction equipment away from noise receptors where feasible;
- Turn off idling equipment when not in use; and
- Install temporary acoustic barriers around stationary construction noise sources, as feasible.

- **BMP-69:** The Project requires mitigation of noise emissions from many different sources in order to meet its commitments regarding noise levels at noise sensitive areas (NSA). Two primary noise sources are the turbine air inlets and exhausts, with key elements of the noise mitigation strategy including the use of silencers. Low-noise lube oil coolers will be installed. In addition, the following key equipment components have been specified with acoustical building enclosures:
  - gas turbines,
  - gas compressors, and
  - Waukesha generator.

  Building enclosures are normally steel sandwich construction: a steel skin, mineral wool within the wall section, and a perforated metal interior wall for sound absorption. At a minimum, walls/roof of the building should be constructed with exterior steel of 22 gauge and an interior layer of 4-inch-thick unfaced fiberglass covered with 26-gauge steel perforated liner. The specification for the compressor building and generator buildings will include noise criteria of 85 A-weighted decibels (dBA) at 3 ft from the building for all penetrations.

If the FERC authorizes the DOF portion of the Project, the FERC staff recommends that the following measures be included as specific conditions in the Commission's Order (Order). The FERC staff believes that these measures would further mitigate the environmental impacts associated with the construction and operation of the proposed Project. Recommendations 1 through 11 are standard conditions typically recommended by FERC staff for pipeline projects. FERC staff recommendations 12 and 13 are Project- and resource-specific, and are listed in Section 4.14.6 and 4.17.6.

- **FERC Rec-1**: Delfin LNG shall follow the construction procedures and mitigation measures described in its applications and supplements (including responses to staff data requests) and as identified in the EIS, unless modified by the Order. Delfin LNG must:
  - Request any modification to these procedures, measures, or conditions in a filing with the Secretary of the Commission (Secretary);
  - Justify each modification relative to site-specific conditions;
  - Explain how that modification provides an equal or greater level of environmental protection than the original measure; and
  - Receive approval in writing from the Director of the Office of Energy Projects (OEP) **before using that modification**.
- **FERC Rec-2**: The Director of OEP has delegated authority to take whatever steps are necessary to ensure the protection of all environmental resources during construction and operation of the project. This authority shall allow:
  - The modification of conditions of the Order; and
  - The design and implementation of any additional measures deemed necessary (including stop-work authority) to assure continued compliance with the intent of the environmental conditions as well as the avoidance or mitigation of adverse environmental impact resulting from project construction and operation.
- **FERC Rec-3**: **Prior to any construction**, Delfin LNG shall file an affirmative statement with the Secretary, certified by a senior company official, that all company personnel, environmental inspectors (EIs), and contractor personnel will be informed of the EI's authority and have been or

will be trained on the implementation of the environmental mitigation measures appropriate to their jobs **before** becoming involved with construction and restoration activities.

- **FERC Rec-4**: The authorized facility location(s) shall be as shown in the EIS, as supplemented by filed alignment sheets, and shall include all of the staff's recommended facility locations identified in the EIS. **As soon as they are available, and before the start of construction**, Delfin LNG shall file with the Secretary any revised detailed survey alignment maps/sheets at a scale not smaller than 1:6,000 with station positions for all facilities approved by the Order. All requests for modifications of environmental conditions of the Order or site-specific clearances must be written and must reference locations designated on these alignment maps/sheets.

  Delfin LNG's exercise of eminent domain authority granted under Natural Gas Act (NGA) section 7(h) in any condemnation proceedings related to the Order must be consistent with these authorized facilities and locations. Delfin LNG's right of eminent domain granted under NGA section 7(h) does not authorize it to increase the size of its natural gas pipeline to accommodate future needs or to acquire a right-of-way for a pipeline to transport a commodity other than natural gas.
- **FERC Rec-5**: Delfin LNG shall file with the Secretary detailed alignment maps/sheets and aerial photographs at a scale not smaller than 1:6,000 identifying all route realignments or facility relocations, and staging areas, pipe storage yards, new access roads, and other areas that would be used or disturbed and have not been previously identified in filings with the Secretary. Approval for each of these areas must be explicitly requested in writing. For each area, the request must include a description of the existing land use/cover type, documentation of landowner approval, whether any cultural resources or federally listed threatened or endangered species would be affected, and whether any other environmentally sensitive areas are within or abutting the area. All areas shall be clearly identified on the maps/sheets/aerial photographs. Each area must be approved in writing by the Director of OEP **before construction in or near that area**.

  This requirement does not apply to extra workspace allowed by FERC's *Upland Erosion Control, Revegetation, and Maintenance Plan* and/or minor field realignments per landowner needs and requirements which do not affect other landowners or sensitive environmental areas such as wetlands.

  Examples of alterations requiring approval include all route realignments and facility location changes resulting from:

  - implementation of cultural resources mitigation measures;
  - implementation of endangered, threatened, or special concern species mitigation measures;
  - recommendations by state regulatory authorities; and
  - Agreements with individual landowners that affect other landowners or could affect sensitive environmental areas.
- **FERC Rec-6: Within 60 days of the acceptance of the authorization and before construction begins**, Delfin LNG shall file an Implementation Plan with the Secretary for review and written approval by the Director of OEP. Delfin LNG must file revisions to the plan as schedules change. The plan shall identify:

  - How Delfin LNG will implement the construction procedures and mitigation measures described in its application and supplements (including responses to staff data requests), identified in the EIS, and required by the Order;
  - How Delfin LNG will incorporate these requirements into the contract bid documents, construction contracts (especially penalty clauses and specifications), and construction

drawings so that the mitigation required at each site is clear to onsite construction and inspection personnel;

- The number of EIs assigned, and how the company will ensure that sufficient personnel are available to implement the environmental mitigation;
- Company personnel, including EIs and contractors, who will receive copies of the appropriate material;
- The location and dates of the environmental compliance training and instructions Delfin LNG will give to all personnel involved with construction and restoration (initial and refresher training as the project progresses and personnel change), with the opportunity for OEP staff to participate in the training session(s);
- The company personnel (if known) and specific portion of Delfin LNG's organization having responsibility for compliance;
- The procedures (including use of contract penalties) Delfin LNG will follow if noncompliance occurs; and
- For each discrete facility, a Gantt or PERT (Program Evaluation Review Technique) chart (or similar project scheduling diagram), and dates for:
  - the completion of all required surveys and reports;
  - the environmental compliance training of onsite personnel;
  - the start of construction; and
  - the start and completion of restoration.

- **FERC Rec-7:** Delfin LNG shall employ at least one EI per construction spread. The EI shall be:
  - Responsible for monitoring and ensuring compliance with all mitigation measures required by the Order and other grants, permits, certificates, or other authorizing documents;
  - Responsible for evaluating the construction contractor's implementation of the environmental mitigation measures required in the contract (see condition 6 above) and any other authorizing document;
  - Empowered to order correction of acts that violate the environmental conditions of the Order, and any other authorizing document;
  - A full-time position, separate from all other activity inspectors;
  - Responsible for documenting compliance with the environmental conditions of the Order, as well as any environmental conditions/permit requirements imposed by other federal, state, or local agencies; and
  - Responsible for maintaining status reports.
- **FERC Rec-8:** Beginning with the filing of its Implementation Plan, Delfin LNG shall file updated status reports with the Secretary on a monthly basis until all construction and restoration activities are complete. On request, these status reports will also be provided to other federal and state agencies with permitting responsibilities. Status reports shall include:
  - An update on Delfin LNG's efforts to obtain the necessary federal authorizations;
  - The construction status of the project, work planned for the following reporting period, and any schedule changes for stream crossings or work in other environmentally-sensitive areas;
  - A listing of all problems encountered and each instance of noncompliance observed by the EI(s) during the reporting period (both for the conditions imposed by the Commission and any environmental conditions/permit requirements imposed by other federal, state, or local agencies);
  - A description of the corrective actions implemented in response to all instances of noncompliance, and their cost;
  - The effectiveness of all corrective actions implemented;

- A description of any landowner/resident complaints which may relate to compliance with the requirements of the Order, and the measures taken to satisfy their concerns; and
- Copies of any correspondence received by Delfin LNG from other federal, state, or local permitting agencies concerning instances of noncompliance, and Delfin LNG's response.

- **FERC Rec-9: Prior to receiving written authorization from the Director of OEP to commence construction of any project facilities,** Delfin LNG shall file with the Secretary documentation that it has received all applicable authorizations required under federal law (or evidence of waiver thereof).
- **FERC Rec-10:** Delfin LNG must receive written authorization from the Director of OEP **before placing the project into service**. Such authorization will only be granted following a determination that rehabilitation and restoration of the right-of-way and other areas affected by the project are proceeding satisfactorily.
- **FERC Rec-11: Within 30 days of placing the authorized facilities in service**, Delfin LNG shall file an affirmative statement with the Secretary, certified by a senior company official:
  - That the facilities have been constructed in compliance with all applicable conditions, and that continuing activities will be consistent with all applicable conditions; or
  - Identifying which of the conditions in the Order Delfin LNG has complied with or will comply with. This statement shall also identify any areas affected by the project where compliance measures were not properly implemented, if not previously identified in filed status reports, and the reason for noncompliance.
- **FERC Rec-12:** Delfin LNG **shall not begin construction** of the DOF facilities and/or use of staging, storage, or temporary work areas and new or to-be-improved access roads **until**:
  - Delfin LNG files with the Secretary:
    - remaining cultural resources survey report(s);
    - determination of whether Delfin LNG would need to reduce the extent of the "no work area" surrounding site 16CM84;
    - site evaluation report(s) and avoidance/treatment plan(s), as required; and
    - comments on the cultural resources reports and plans from the Louisiana SHPO.
  - The Advisory Council on Historic Preservation is afforded an opportunity to comment if historic properties would be adversely affected; and
  - The FERC staff reviews and the Director of OEP approves the cultural resources reports and plans, and notifies Delfin LNG in writing that treatment plans/mitigation measures (including archaeological data recovery) may be implemented and/or construction may proceed.

    All materials filed with the Commission containing **location, character, and ownership information** about cultural resources must have the cover and any relevant pages therein clearly labeled in bold lettering: "**CONTAINS PRIVILEGED INFORMATION - DO NOT RELEASE**."

- **FERC Rec-13:** Delfin LNG shall file a noise survey with the Secretary **no later than 60 days** after placing the DOF Compressor Station in service. If a full load condition noise survey is not possible, Delfin LNG shall provide an interim survey at the maximum possible horsepower load and provide the full load survey **within 6 months**. If the noise attributable to the operation of all of the equipment at the DOF Compressor Station under interim or full horsepower load conditions exceeds an L_{dn} of 55 dBA at any nearby NSAs (or noise-sensitive areas), Delfin LNG shall file a report on what changes are needed and shall install the additional noise controls to meet the level **within 1 year** of the in-service date. Delfin LNG shall confirm compliance with the above requirement by filing a second noise survey with the Secretary **no later than 60 days** after it installs the additional noise controls.

A complete list of BMPs and agency recommendations is included in Appendix G.

OFFSHORE ENVIRONMENTAL CONSEQUENCES

4.2 Offshore Water Resources

The proposed Project area under consideration is divided into coastal and marine waters. The proposed offshore components and associated pipeline interconnects would be in the marine waters of the nearshore Gulf of Mexico between Sabine Pass and the Calcasieu River. Marine waters, as defined in this document, include Louisiana and Texas State, and Federal jurisdictional waters in the vicinity of the proposed Project site.

Activities associated with construction and operation of the proposed Project that would impact offshore water resources include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- pipeline operations including periodic pigging;
- FLNGV and LNGC operational withdrawals and discharges, including discharge of ballast water, bilge water, scrubber water, and sanitary waste water;
- hazardous and nonhazardous deck drains during operations;
- use of cooling water during operations;
- discharge of reverse osmosis reject water during operations; and
- accidental releases of fuel, oil, and other chemicals during construction and operations.

The sections that follow provide impact analyses for Delfin LNG's proposed site on water resources, including water quality. Sediment quality is addressed in Section 3.5.5.6. The section concludes with a comparison of impacts for Delfin LNG's alternative deepwater port design, alternative cooling media, and alternative anchoring media. BMPs are also discussed.

4.2.1 Physical Oceanography

The proposed Port and associated pipeline segments (seaward of the high water mark) would be in marine waters of the Gulf of Mexico. The physical oceanography of the Gulf of Mexico is influenced by conditions and processes including bathymetry, wave action, tides, winds, and currents.

4.2.1.1 Impacts of Construction

Marine currents potentially could be affected by installation of the proposed Port and associated pipeline segment construction and would cause turbulence and eddies in the downcurrent shadow of these operations. The flow changes and disruptions would extend a short distance downcurrent before returning to ambient conditions. Therefore, impacts on physical oceanographic conditions (currents, tides, and wave patterns) associated with the presence of these structures would be anticipated to be short-term and negligible, as the Region of Influence (ROI) covers a minor area within the context of the larger Gulf of Mexico oceanographic environment. DP vessels, if used, would have no turbidity-related water quality impacts associated with vessel positioning; however, minor eddies and increased flow velocities are expected that would extend short distances downgradient of the construction operations.

Installation of the proposed Project components, such as the tower yoke mooring systems (TYMS), would cause minor, short-term changes of the seafloor topography (bathymetry). These would be confined to the construction zone and nearby areas, where disturbed sediments would resettle to the bottom. Disturbed areas over time would be allowed to return to pre-disturbance conditions by natural processes and currents. Because sediment disturbance would be short-term and reversible, the impacts on physical oceanography during construction would be negligible.

4.2.1.2 Impacts of Operation

Negligible impacts on the physical oceanography would result from changes in flow and velocities due to the presence of the proposed Port facilities blocking and redirecting flow. No modeling has been conducted for these impacts, but it is expected that currents should return to ambient conditions immediately downcurrent from the current disrupter. Section 3.2.5.1 discusses the currents within the Gulf of Mexico. The interaction of wind stress, tide, and the Florida current system causes a circular current known as the Loop Current. As also discussed in Section 3.2.5.1, surface currents in the proposed Port area are primarily wind- and tide-driven, causing the cyclonic circulation of the Louisiana-Texas Coastal current. Based on the relative size of the proposed Port facilities with respect to the Gulf of Mexico and the fact that the driving forces on currents are much larger than the Gulf of Mexico itself, current at depth would return to ambient conditions downcurrent of the proposed Port facilities. The proposed Port facilities would have minimal effects on surface currents when vessels are moored to the TYMS.

4.2.1.3 Impacts of Decommissioning

Short-term, minor direct impacts on the physical oceanography associated with decommissioning would be similar to those associated with construction, but because they happen over a much smaller area (the proposed pipeline structures would be abandoned in-place, to be consistent with current Federal policies to minimize adverse impacts; see BOEM's Notice to Lessees [NTL] No. 2010-G05), the extent of the impacts would be less. The decommissioning of each TYMS would result in localized turbidity and minor short-term changes in current and wave action from disturbances on the seafloor and decommissioning vessels.

4.2.2 Water Quality

The proposed Port and associated pipeline segments (seaward of the high water mark) would be in marine waters of the Gulf of Mexico. The proposed Project area under consideration is divided into coastal and marine waters. The proposed offshore components and associated pipeline interconnects would be in the marine waters of the nearshore Gulf of Mexico between Sabine Pass and the Calcasieu River delta. The portion of the Gulf of Mexico nearest the proposed Project site is designated by the Louisiana Department of Environmental Quality (LDEQ) as estuarine and warm water (Subsegment 031201) and includes water from the Calcasieu River Basin Coastal Bays to the Gulf of Mexico, 3 miles offshore. Designated uses for this waterbody include primary contact recreation, secondary contact recreation, and oyster propagation.

The proposed Port would not be located in State coastal waters; however, operational activities, including pipelines landward of the mean high water mark, of the proposed Project would cross coastal zones of Louisiana. Coastal areas are influenced by the influx of freshwater and sediment from rivers and the tidal actions of the oceans. The primary parameters that can influence coastal water quality include water temperature, salinity, total dissolved solids (TDS), and total suspended solids (TSS), turbidity, and nutrients. An estuary's salinity and temperature regimes are determined by hydrodynamic mechanisms, including tides, nearshore circulation patterns, freshwater discharge from rivers, and local precipitation.

4.2.2.1 Impacts of Construction

Construction-related impacts on water quality would originate from offshore Port construction and pipeline installation activities in addition to water discharges related to construction and tending water construction vessels operating at the proposed Project site. Additionally, pipeline integrity testing would include hydrostatic water testing requiring the withdrawal and discharge of hydrostatic test waters into adjoining waters of the Gulf of Mexico following completion of the test(s).

Mooring Platforms and Pipeline Construction

Potential impacts during construction would include the modification of aquatic habitat by the conversion of approximately 0.15 acre (total footprint of the proposed Port and TYMS combined) of soft-bottom to hard-surface structures that would be attractive to hard-bottom reef species, increased sedimentation (i.e., accumulation and redistribution of sediment on waterbody bottom) and turbidity (a measure of water clarity) from piling installation activities, increased water discharges from associated tending vessels, suspension of sediments during pipeline installation, and the introduction of fuels and lubricants via accidental spills or releases by construction equipment and tending vessels. The greatest potential to affect surface waters would result from suspension of sediments and associated increases in turbidity caused by trenching or jetting during the pipeline installation. Jetting or pile-driving activities may result in the suspension of sediments and subsequent release of these sediment-based contaminants to the water column.

BOEM requires that the pipeline be buried at least 3 ft (approximately 1 m) below the mudline (30 CFR 250.1003(a)(1)). This is done to prevent potential impacts on the pipeline caused by high currents and storms, anchors, and fishing gear, and to minimize interference with other operations on the continental shelf.

Short-term, direct, minor, adverse water quality impacts would occur during installation of the proposed marine pipelines. All the proposed pipeline segments would be installed in water depths less than 200 ft (61 m) via jet-trenching (using a jet-sled trencher). Typically, a jetted trench has a V-shaped cross-section ranging in width from approximately 30 ft (9 m) at the trench top to 10 ft (3 m) at the trench bottom.

Trenching for the pipeline and laterals using a jet-sled trencher would suspend sediments in the water column during the jetting and pipeline installation operations. Delfin LNG predicted (MMS 2001) that 2 cubic yards (1.5 cubic meters [m^3]) of sediment could be resuspended for each foot (0.3 m) of pipeline trenched. As a result of pipeline installation and other construction-related bottom disturbance activities (i.e., anchoring of construction and lay barges), the 5 miles (8 kilometers [km]) of new pipeline could result in the suspension of up to 52,600 cubic yards (40,000 m^3) of sediment during pipeline installation. This information is tabulated in Table 2.2-4.

Due to water depths in the vicinity of the pipeline and the mooring platform, once trenching is complete, local water turbidity should return to pre-trenching levels without any mitigation. The duration for this post-excavation residency time of these sediments in the water column would vary with the particle size and currents. Coarser sediments (i.e., coarse sands and gravel) would resettle quickly (within hours), while finer sediments (i.e., silts and clays) would remain suspended for longer periods (days) depending upon ambient water currents, storm activity, water sheer velocities, and sediment cohesiveness and extend for days or weeks.

Chemical analysis of the sediments from the proposed Project area indicated that concentrations of detected contaminants were below or only slightly exceeded water quality standard values. Based on these observed conditions, the low-level concentrations suggest the suspension of sediments during jetting and trenching construction would not result in the introduction of contaminants into the water column during pipeline construction.

Construction of the proposed Port would require the use of construction barges and support vessels to install piling supports and submarine infrastructure at the site. Construction vessels and watercraft would have associated discharges related to cooling water, sanitary systems, bilge, ballast control and other service water systems. Localized operations by these vessels would temporarily increase associated discharges from these sources. All construction related vessel discharges would be in compliance with USCG requirements and/or the MARPOL. Constituents such as oil and grease associated with vessel machinery rooms and hydraulic support systems would be managed in compliance via oily water separators prior to discharge in compliance with vessel requirements. Sanitary discharges would be managed via approved marine sanitation devices (MSDs) on board these vessels.

Construction vessel positioning and stabilization would be managed via remote anchoring systems. This anchoring process would require the deployment of multiple anchors for securing construction barges and vessels over the work zone. These operations would result in temporary and localized increases in suspended solids in the water column during these operations. These increases may result in temporary exceedances of water quality standards. The LDEQ standard for turbidity for estuarine waters is to possess turbidity levels of <50 nephelometric turbidity units (NTUs) in order to remain in compliance with State water quality standards. For marine waters within State limits, turbidity levels should not exceed 10 percent above ambient background (Title 33 Environmental Quality Part IX Water Quality, Subpart 1. Water Pollution Control). Exceedance of these criteria are expected within the construction area of the Project, though sediment plume modeling has not been performed to assess trends in turbidity relative to these activities. Temporary exceedance of these standards may be exempt for short periods of time that are certified under Section 402 or 404 or certified under Section 401 of the CWA such as maintenance dredging of navigable waterways or other short-term activities determined by the State as necessary to accommodate legitimate uses or emergencies. Ambient levels of turbidity in the Gulf of Mexico are highly influenced by the discharges of major river basins and will naturally vary with suspended sediment loading and turbidity trends associated with these sources. The relative contribution of any increase in turbidity or TSS within the proposed Project area would be minor to the Gulf of Mexico basin as a whole. Piling installation would also result in temporary suspension of sediments during installation. Likewise, these localized increases would be temporary to the construction activity area and would represent a short-term, minor adverse impact on water quality in the area.

Analytical chemistry data for sediments from the area revealed that none of the organic compounds or metals exceeded either their corresponding low or high effect level screening values, other than dioxins and furans (collectively summed as toxic equivalents). Not all of the dioxin/furan data exceeded the lower benchmark value for these compounds and none of the samples exceeded the higher screening benchmark value above which it is probable that negative effects on benthic biota may occur. Since none of the detected constituents exceeded the upper threshold benchmark, impacts on aquatic life from the release of contaminants from suspended sediments are considered to be minor.

Hydrostatic Testing

The proposed marine pipelines would be hydrostatically tested to ensure their integrity before being placed into service. Hydrostatic testing of the former UTOS pipeline would require approximately 10.5 million gallons (Mgal) of water. The water would be withdrawn from the Gulf of Mexico at WC 167. The HIOS line would be tested with water withdrawn from the Gulf of Mexico at HI A264. Approximately 22.6 Mgal would be required to fill the HIOS pipeline, and an additional 0.9 Mgal would be required for hydrostatic testing of all lateral and the WC 167 bypass pipelines. During hydrostatic testing, water would be pumped into the pipe and filtered through a 100-size mesh screen (mesh opening – 0.0059 inch [0.15 millimeter]) to prevent debris and foreign material from entering the pipeline. The UTOS and HIOS fill water would be tested for hydrocarbons and other contaminants for consistency with any NPDES-related permit requirements. If needed to meet water quality requirements, the water would be filtered and treated prior to discharge to the Gulf of Mexico. The total volume of water discharged from the UTOS and HIOS pipelines and the four laterals would be approximately 34.0 Mgal. Discharge rates would be limited to approximately 2,000 gallons per minute (gpm) (7,570 liters per minute) and discharges would be released through an end of pipe diffuser positioned below the water surface. Prior to construction, Delfin LNG would secure a NPDES permit for the hydrostatic test water to be discharged to the Gulf of Mexico

Accidental Spills and Releases

Operations of the construction vessels and associated equipment would require routine refueling and maintenance needs during the construction period. Inadvertent spills of hydrocarbons or other hazardous substances from construction vessels pose a risk to water quality. Vessels associated with installation of the proposed marine pipelines would be equipped with spill containment and cleanup equipment to respond to small, accidental releases of bunkers, lubricants, or other chemicals. This would include the transfer of diesel fuel, lubricants, hydraulic fluids, coolants, fire control fluids and other associated materials needed for normal vessel maintenance operations from supply vessels to the construction barges and vessels. Potential spills of such liquids and materials may occur during needed refueling and maintenance operations. BMPs would be followed in accordance with USCG operating standards for transferring of these materials between vessels. These BMPs would include training, proper personal protective equipment, and temporary evacuations of personnel working near the delivery area. BMPs would be detailed in vessel SPCC Plans and would address the handling and storage requirements for hazardous materials and incorporate spill contingency procedures, include the designation of refueling areas at a safe distance from potential ignition sources and include the training of employees to respond to hazardous materials spills and to operate basic fire protection equipment during construction activities.

4.2.2.2 Impacts of Operation

Impacts of operations of the proposed Port would include routine operations of the FLNGVs, the platform, and maintenance operations of the pipeline. Pipeline operating impacts on water quality would be intermittent and associated with periodic pipeline maintenance operations. The moored FLNGVs would be fully operational vessels with associated water intake and discharges associated with their normal operation and function autonomously from each other and the platform.

Pipeline Operations

Maintenance of the pipeline would include periodic pigging to clean out residual matter within the pipeline. The unmanaged release of accumulated materials into the surrounding environment would potentially lead to water quality impacts. Neither the HIOS nor the UTOS systems are set up for the use of a smart pig, and Delfin LNG has no plans to make these pipelines smart pig accessible. Traditional pigging requires the pig to be launched from a launching station and pushed through the pipeline system to the receiving station using the gas pressure and flow of the pipeline. Residual materials cleaned out by the pig are removed at the receiving station. Inert nitrogen gas is inserted at the both the launching and receiving stations during insertion and removal of the pig, respectively, to prevent release of natural gas from the pipeline system. All discharge activities associated with pipeline cleaning operations would be managed and wastes treated prior to discharge under applicable NPDES permits or contained and transported for treatment off-site at an approved treatment facility. While unlikely, waste materials (liquids, sludges, and/or solids removed from a pipeline during pigging operations) could be accidently spilled, impacting water quality. Impacts associated with these activities would be avoided or minimized by protective measures developed in an SPCC Plan and FRP.

FLNGV Operational Withdrawals

The greatest influence on water quality and water use for the proposed Project is the operation of the four FLNGVs and the proposed Port. The four individual FLNGVs would withdraw water from the Gulf of Mexico for use in daily service water and cooling water systems. In addition to water withdrawal, the FLNGVs would be fully autonomous vessels with associated discharges to the receiving waters of the Gulf of Mexico that would represent a variety of treated waste streams. These discharges reflect normal vessel equipment operations and support of the full-time maritime crew on each FLNGV. Cooling water needs onboard the FLNGVs would be limited to only intermittent needs for the essential generators because an air cooling system would be employed on each FLNGV for engine cooling purposes. Table 4.2-1 presents the projected water balance for seawater by individual support system on board the FLNGVs.

Table 4.2-1. Water Balance for Withdrawals and Discharges for a Single and Four Operational FLNGVs

Service	Seawater Intake Rate per FLNGV (gpm)	Periodic Water Use of Single FLNGV	Total Seawater Intake Rate d/ (gpm)	Average Daily Intake Rate Per FLNGV (mgd)	Total Average Intake Rate for 4 FLNGVs (mgd) d/
Desalination System (Freshwater Generator) (Continuous)	683	Continuous need, a/	2,732	0.983	3.93
Ballast System (Continuous)	11,000-19,200 b/	Continuous need 18,000,000 gallons per off-take cycle with 40 off-takes per a 336-day production year	44,000-76,800	2.14 c/	8.56
Cooling Water for Essential Generators (Intermittent)	600	Intermittent need, 30 minutes once every 2 weeks	2,400	0.00128	0.00512
Firewater Pump Testing (Intermittent)	7,000	Intermittent need, Once a week for 1 hour	28,000	0.0299	0.1196
IGG Scrubber Water (Intermittent)	50-75	Intermittent need, One 72-hour period per year	200-300	0.000739	0.0029
Water Curtain (Intermittent)	400	Intermittent need, One 32-hour period every 8.4 days	1,600	0.0905	0.362
			Total Daily Average:	**3.24**	**12.98**

Notes:
a/ Desalination system seawater intake rate is based on 35% recovery rate of first pass Reverse Osmosis system
b/ Ballast intake averages 12,500 gpm over a 24-hour period
c/ Ballast discharge rate of 1,690 gpm over a 7.4-day period
d/ Combined intake and discharge volumes for four FLNGVs
Key:
gpm = gallons per minute
mgd = million gallons per day
IGG = inert gas generator scrubber
LNG = liquefied natural gas

Maximum daily withdrawal of seawater by one FLNGV is estimated at up to 3.9 million gallons per day (mgd) when all systems are operating simultaneously. However, such a condition does not represent a typical operating scenario as not all systems will be running continuously. Many systems will be run intermittently as per Table 4.2-1. Average seawater withdrawals are expected to be approximately 3.24 mgd per FLNGV over the course of an annual operating year. Continuous withdrawals are associated with the desalination plant system and ballast systems of the individual FLNGVs. Combined, these two systems would withdraw up to 3.12 mgd per FLNGV or approximately 12.5 mgd for the four operational FLNGVs on a cumulative basis. Intermittent withdrawals are associated with the water curtain, inert gas generator (IGG) scrubber unit, firewater system tests, and testing of the essential generators (Table 4.2-1). On an average annual basis, these withdrawals would approximate 0.12 mgd per FLNGV. Discharge volumes on a daily basis would closely parallel the above intake volumes with exception of the freshwater generator, ballast systems, and sanitary discharges. Ballast-related discharges would be variable depending upon vessel operational needs and service water system status.

The FLNGV seawater intakes would consist of two small, high sea chests and two large, lower sea chests. The sea chests are rectangular with dimensions of approximately 2.5 by 3.5 m for the lower sea chests and 1.2 by 2.0 m for the high sea chests. Water for the desalination system and IGG scrubber would be withdrawn through the high sea chest. Ballast, cooling water for the essential generators, the water curtain, and the firewater system flow would be withdrawn through the two lower sea chests. The ballast and water curtain would be run simultaneously and separately from the essential generator and fire water pump tests.

The ballast intake and water curtain running simultaneously generate a combined maximum intake flow of 19,600 gpm across an intake area of approximately 100 square feet (ft^2) of the lower sea chests, generating a maximum approach velocity of approximately 0.43 feet/second (ft/s). In the high sea chests, the desalination system intake and the IGG scrubber water intakes, running simultaneously, and have a maximum approach velocity of approximately 0.06 ft/s. For both the high and low sea chests, an approach velocity of less than 0.5 ft/s is maintained, thus mitigating for fish impingement effects and brings the system in compliance with Section 316(b) of the CWA for reducing impingement impacts. Total average daily withdrawal would approximate 3.24 mgd for all systems (Table 4.2-1). A small volume of withdrawn water will be retained for freshwater water supply replenishment and service water needs. Average daily discharge will be slightly lower than the withdrawn volume to account for this need.

Withdrawn seawater would be treated in the sea chests with chlorine via an on-board hypochlorite generator and sacrificial copper anodes for biofouling control. Chlorine would be present in all the seawater service systems. Seawater would be filtered upon entering the sea chests in the hull, and the strainer would be intermittently cleaned with a compressed utility air system. Withdrawn water would be treated with chlorine from the chlorine generator, which produces a diluted solution of sodium hypochlorite for intermittent injection into the sea chest to prevent marine and biological fouling. The seawater would be pumped to its different systems, including ballast systems, service water, essential generator cooling systems, and water curtains. Seawater in the desalination system would be run through a seawater filtration system and then sent to the reverse osmosis (RO) freshwater generation system to supply the utility water to the vessel service systems. The utility and potable water feed water would be further treated in the potable water treatment package using a chlorination and ultra-violet disinfection system and demineralizer treatment system

FLNGV Operational Discharges

Each FLNGV would have nine discrete discharge ports or overboard discharges servicing multiple on-board service and operational systems. Two systems, the overboard water curtain and fire water systems will have separate multi-port systems on either side of the vessel. Vessel operational discharges are expected to be long-term impacts on the local waters of the proposed Project area. Table 4.2-2 describes the source of the discharge stream, port location, flow rate, and estimated velocity of the discharges of each FLNGV.

Table 4.2-2. Marine Discharge Ports and Flow Rates for a Single FLNGV

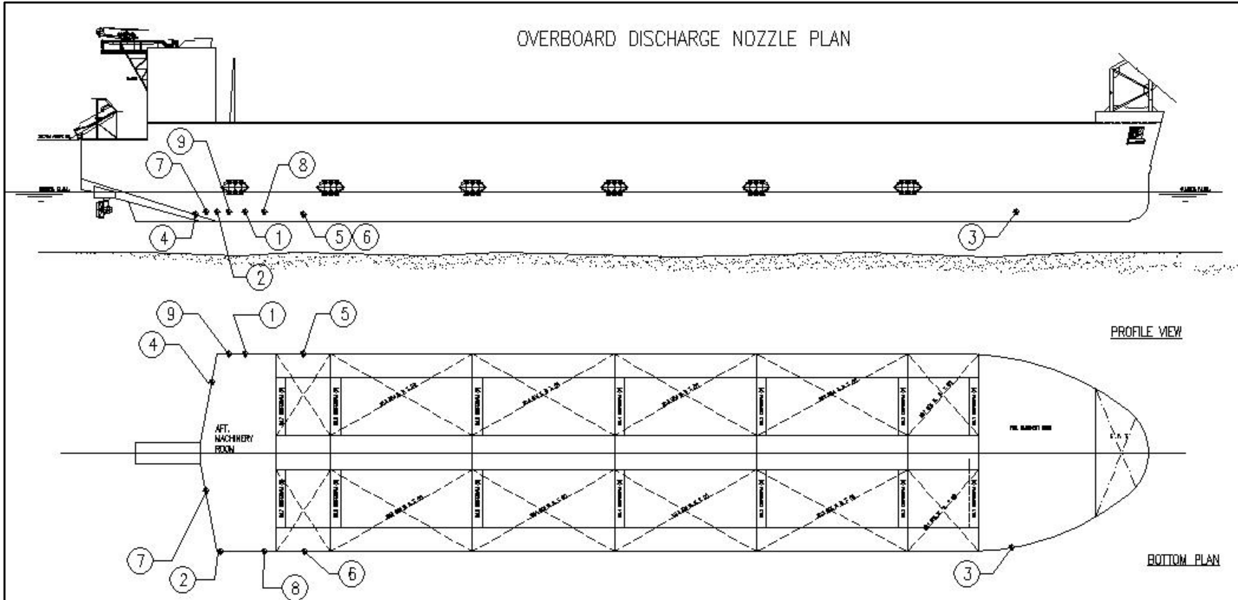
Source No.	Discharge	Orientation	Average Daily Single FLNGV Discharge Rate (mgd) a/	Total Discharge for Four FLNGVs (mgd)
1	Ballast water (Continuous)	Aft hull portside underwater	2.41	9.64
2	Aft machinery room bilge water (Continuous)	Aft hull starboard side underwater	0.0036	0.014
3	Forward machinery room bilge water (Continuous)	Forward hull starboard side underwater	0.0036	0.014
4	Sewage treatment discharge (Continuous)	Aft hull portside underwater	0.028	0.11

Table 4.2-2. Marine Discharge Ports and Flow Rates for a Single FLNGV (continued)

Source No.	Discharge	Orientation	Average Daily Single FLNGV Discharge Rate (mgd) a/	Total Discharge for Four FLNGVs (mgd)
5	No. 1 Slop tank discharge (1st separation)	Aft hull portside underwater	No flow	No flow
6	No. 2 Slop tank discharge (2nd separation) (Continuous) b/	Aft hull starboard side underwater	0.0074	0.0296
7	Diesel generator cooler discharge (Intermittent)	Aft hull starboard side underwater	0.0013	0.0052
8	IGG scrubber discharge (Intermittent)	Aft hull portside underwater	0.00059	0.0023
9	RO reject water discharge (Intermittent)	Aft hull portside underwater	0.638	2.55
NA	Fire water test (Intermittent)	Various locations on board	0.029	0.116
NA	Water curtain (Intermittent)	Vertical sheet flow from hull	0.090	0.36
		Total Discharge Volume:	**2.96**	**11.84**

Notes:
a/ For average daily operation of an FLNGV
b/ Variable flow and discharge operation depending upon rain fall collection from deck drains, assumes one 7 hour cycle per major rainfall event with a frequency of one major event per week.
Key:
mgd = million gallons per day
IGG = inert gas generator
NA = not applicable
RO = reverse osmosis

Figure 4.2-1 presents the schematic of a typical FLNGV vessel in profile and bottom view, showing individual, discrete discharge port locations described in Table 4.2-2 with the exceptions of the water curtain and fire water test locations. Both of these discharges would occur as individual flows from both port and starboard locations as part of their normal multiport operation and not from a single discrete outlet. The four FLNGVs would be attached to the proposed Port via windthrow pivots allowing them to pivot in the prevailing wind and currents. This movement would cause a discharge influence over a greater area of marine waters than a fixed discharge port discharging from a stationary location. Discharge characteristics for individual sources of discharges are discussed in the sections below. Total average daily discharge would approximate 3.21 mgd for all systems for a 365-day operating year.



NOZZLE NUMBER AND ASSOCIATED DISCHARGE					
1	Ballast water	4	Sewage treatment discharge	7	Diesel generator cooler discharge
2	Aft machinery room bilge water	5	No. 1 Slop tank discharge (1st separation)	8	IGG scrubber discharge
3	Forward machinery room bilge water	6	No. 2 Slop tank discharge (2nd separation)	9	RO reject water discharge

Figure 4.2-1. Schematic of Overboard Port Locations on FLNGV (Over deck water curtain and fire water discharges are not depicted)

Ballast Water Discharge

Ballast water use and discharge would be a dynamic continuous discharge as the system would be responding to changes in vessel stability based on sea condition, vessel takeoff operations, and vessel righting needs in response to LNG storage and transfer processes. These discharges would be long-term but considered minor impacts on water quality given that these waters are not associated with any process systems. Ballast water would be stored in ballast tanks and treated with sodium hypochlorite to prevent biofouling within the tanks and ballast pump systems. All vessels would be required to meet CFR Title 46, Chapter I, Subchapter Q, Part 162 that addresses requirements for ballast water management systems (BWMS) to be installed onboard vessels for the purpose of complying with the ballast water discharge standard of 33 CFR part 151, subparts C and D. Additional treatment via a copper aluminum anode system would also occur. A typical constituent profile for the ballast water discharges is presented in Table 4.2-3.

A pair of copper and aluminum anodes is provided in the sea chests for preventing growth of fouling organisms (i.e., barnacles and mussels) in the distribution system. The copper anode releases a very small quantity of less than 2 micrograms per liter (µg/L) into the withdrawn water. The action of the copper ions is assisted by aluminum hydroxide created by the aluminum anodes, which flocculates the released copper from the copper anodes. A cupro-aluminum film is built up on the internal surfaces of the system piping, depleting the copper-aluminum ions in the treated water to suppress corrosion and limit fouling of the internal piping surfaces. USEPA marine water criterial for copper is 4.8 µg/L for acute and 3.1 µg/L for chronic criteria for marine life (USEPA 2016). Given that the dosed level of copper is below the USEPA water quality criteria for marine life, impacts on marine organisms from exposure to this discharge are expected to be minor.

Table 4.2-3. Ballast Water Discharge Characteristics for FLNGVs a/

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Ballast Water	Water Ballast Tanks	Continuous	Biochemical Oxygen Demand (BOD)	0.8
			Chemical Oxygen Demand (COD)	1.0
			Total Organic Carbon (TOC)	2.5
			Total Suspended Solids (TSS)	25
			Ammonia (N)	0.02
			Winter Temperature (°F)	75
			Summer Temperature (°F)	80
			Total Residual Chlorine a/	0.5
			Copper (µg/L) a/	2.0

Note:
a/ Concentration shown is the dose administered for effective biofouling control and due to organic complexation and scavenging would be lower when finally discharged.
Key:
°F = degrees Fahrenheit; µg/L = microgram per liter; mg/L = milligram per liter

Additional macrofouling control would include dosing the water intake system with chlorine at a concentration of 0.5 milligram per liter (mg/L) of total chlorine from the on-board sodium hypochlorite generator. This concentration exceeds the USEPA ambient water quality acute and chronic criteria of 0.013 mg/L and 0.007 mg/L. Within the water intake system, residual chlorine levels from this treatment would be chemically scavenged. Use of chlorination would be regulated by USEPA water effluent standards for NPDES permits. The NPDES permit limits would dictate chlorination rates and frequency to bring the chlorine concentrations at the discharge into compliance with effluent standards and requirements.[23]

Risks for introduction of invasive marine species from ballast water in the FLNGVs is considered negligible because the vessels would be docked at the proposed Port. Exchange of ballast water would be localized to the proposed Port waters on a daily basis but would still be conducted in accordance with the requirements for BWMS to be installed onboard vessels for the purpose of complying with the ballast water discharge standard of 33 CFR part 151, subparts C and D. Visiting LNGCs calling on the proposed Port would have the potential to carry organisms from other waters but would be subject to the International Maritime Organization (IMO) standards and USCG ballast water regulations and practices as set forth in the National Invasive Species Act of 1996 (16 United States Code [U.S.C.] § 4701) for managing ballast water to prevent introduction of invasive marine organisms in U.S. waters.

Bilge Water Discharges

Two bilge water discharges are identified on the hulls of the FLNGVs as depicted in Figure 4.2-1. Bilge water represents the collected water from operations level leakage and collection of associated spills or overflows of machinery fluids and seawater. The FLNGVs would be subject to an NPDES Individual Permit issued for the proposed Port that is expected to largely mimic the discharge requirements of USEPA Region 6 General Permit 290000 applicable to offshore oil and gas extraction facilities. MARPOL allows for the discharge of bilge water from vessels after the effluent has been treated by an approved oil water separator and analyzed to confirm that it does not exceed an oil and grease concentration of 15 parts per million (ppm). Bilge discharges would be monitored via an in-line oily water separator and alarm system aboard each FLNGV to ensure that the treatment units are capable of meeting the bilge water discharge requirements. In-line oily water monitoring systems are used to ensure

[23] https://www.gpo.gov/fdsys/pkg/FR-2015-11-03/pdf/2015-25663.pdf

that discharges are compliant with MARPOL and NPDES discharge permit requirements. If discharges are greater than 15 mg/L, the oily water would be diverted to the primary slope tank for resettling, or pumped off to allow for compliance with the less than 15 mg/L standard when operating as a vessel (i.e., MARPOL requirements) or when connected to the TYMS and subject to an NPDES general permit and meeting a permit applied standard similar to USEPA Region 6 General Permit 290000 (i.e., no free oil). Additional limits may be placed on the NPDES permit form based on the expected constituents to be encountered. A typical constituent profile for the bilge water discharges is presented in Table 4.2-4.

Table 4.2-4. Bilge Water Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Bilge Water (Forward and Aft)	Bilge Sumps	Intermittent	Biochemical Oxygen Demand (BOD)	10
			Chemical Oxygen Demand (COD)	75
			Total Organic Carbon (TOC)	20
			Total Suspended Solids (TSS)	10
			Ammonia (N)	40
			Winter Temperature (°F)	85
			Summer Temperature (°F)	90
			Total Residual Chlorine a/	0.5
			Copper (µg/L) a/	2.0
			pH	6-9
			Oil and Grease	10.0

Notes:
a/ Concentration shown is the dose administered for effect biofouling control and due to organic complexation and scavenging would be lower when finally discharged.
Key:
°F = degrees Fahrenheit; µg/L = microgram per liter; mg/L = milligram per liter

Scrubber Water Discharges

Scrubber systems are used to strip air emissions of carbon dioxide, sulfur-based, or nitrogen greenhouse gases prior to stack release. The primary mechanism for this stripping process is through liquefaction of the particulates and targeted air emission compounds using water-based stripping liquids and subsequent concentration via evaporators. This process generates condensate within the scrubber process where excess water and scrubber condensate is managed via different methods. Condensate is sorbed or concentrated for disposal and, in the case of this Project, excess water would be discharged to the Gulf of Mexico. A typical constituent profile for IGG scrubber water discharges for the FLNGVs is presented in Table 4.2-5.

Table 4.2-5. Scrubber Water Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Scrubber Water	Engine Operation Emissions	Intermittent	Biochemical Oxygen Demand (BOD)	0.8
			Chemical Oxygen Demand (COD)	1.0
			Total Organic Carbon (TOC)	2.5
			Total Suspended Solids (TSS)	25
			Ammonia (N)	0.02
			Winter Temperature (°F)	75
			Summer Temperature (°F)	80
			Total Residual Chlorine a/	0.5
			pH	8.0
			Oil and Grease	5.0

Note:

a/ Concentration shown is the dose administered for effect biofouling control and due to organic complexation and scavenging would be lower when finally discharged.

Key:

°F = degrees Fahrenheit; µg/L = microgram per liter; mg/L = milligram per liter

Sanitary Discharges

Black water (i.e., sanitary wastes from toilets and urinals) and grey water (i.e., non-sanitary generated water streams such as sink and kitchen sources) onboard the FLNGVs would be collected and treated via a USCG Type II marine sanitation device (MSD). The MSD would use an advanced wastewater treatment unit on each FLNGV and the units would provide electrochlorination/electro-coagulation type treatment, including a settler and clarifier. These processes would act to remove solids, concentrate particulates through filtering, and disinfect the effluent from the sanitary management system prior to discharge. Each FLNGV would be autonomous in its sanitary management and would discharge treated effluent independently from each vessel. It is estimated that the combined sanitary and domestic wastewater treatment unit would discharge up to 28,800 gallons per day per FLNGV based on a discharge rate of 20 gpm. The flow rate to the unit may range from 10 to 40 gpm throughout daily operations. Combined, the four FLNGVs would contribute a median discharge of 115,200 gpm of treated sanitary effluent to the Gulf of Mexico, assuming a continuous discharge scenario. Additionally, the tugboats, service/supply vessels, and LNGCs would have their own sanitary waste systems that are independent of the proposed Project. Table 4.2-6 presents a typical sanitary discharge profile for this discharge from the FLNGV.

Treated domestic sanitary water would be routinely discharged from the proposed Port in accordance with the CWA (Section 312), NPDES permits, and USCG regulations to prevent long-term impacts on water quality. NPDES effluent standards would be enforced to comply with water quality standards set by the water quality certificate and the USEPA Region NPDES program. Sanitary and domestic water discharges would introduce additional carbon and macronutrients (e.g., phosphorus and nitrates) into the water column of the Gulf of Mexico. The Gulf of Mexico has the largest number of public sewage treatment discharges along the coastal United States. The additional source of carbon and nutrients from the FLNGVs would be a minor contribution to the overall enrichment of the Gulf of Mexico and possibly to the anaerobic conditions present in the deeper waters. These discharges of sanitary wastes and domestic wastes would be diluted and dispersed (i.e., to ambient levels within a few meters of the discharge) and would be dissipated within the mixing zone of the discharge. Relative to the volume of the receiving waters, the discharge would not be considered a major source of nutrients to the Gulf of Mexico relative to the sources associated with contributions from the Mississippi and Calcasieu River basins. Therefore, these discharges are expected to be long-term and minor in their impact on water quality in the Gulf of Mexico.

Table 4.2-6. Sanitary Water Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Grey and Black Water	Marine Sanitary Device	Continuous	Biochemical Oxygen Demand (BOD)	10.0
			Chemical Oxygen Demand (COD)	75.0
			Total Organic Carbon (TOC)	20.0
			Total Suspended Solids (TSS)	10.0
			Ammonia (N)	40.0
			Winter Temperature (°F)	85.0
			Summer Temperature (°F)	90.0
			Total Residual Chlorine a/	0.5
			Copper (µg/L) a/	2.0
			pH	6-9
			Fecal Coliform (cfu/100 mL)	15.0

Notes:
a/ Concentration shown is the dose administered for effect biofouling control and due to organic complexation and scavenging would be lower when finally discharged.
Key:
cfu = Colony forming units; µg/L = micrograms per liter; mL = milliliter

Hazardous and Nonhazardous Deck Drains

Equipment that has the potential to release hydrocarbons would include drain pans to capture any released hydrocarbons and contaminated rainwater. The open drain system would collect rainwater, wash water, and other fluids, which would be pumped or gravity drained to on-board slop tanks. Two slop tanks in series would store and treat oily water by gravity separation. Treated water meeting Federal requirements would be discharged to the Gulf of Mexico through an outfall pipe located below water level after being monitored for compliance with NPDES effluent standards. Free oil collected at the top of the water layer would be removed using floating oil skimmers and routed to an oil/sludge collection tank for treatment via a hydrocyclone for separation of oil and solids.

Treated water would be discharged to the sea if it contains less than the MARPOL standard of 15 ppm of oil and grease or an equivalent standard as established by the NPDES operating permit. Oily water discharge monitoring equipment would be installed in each FLNGV to ensure compliance with the regulatory requirements consistent with NPDES, USCG, and MARPOL standards. If the oil and grease content of the monitored source water is higher than the established oil and grease standard, an exceedance alarm would sound and the source water from the discharge would be re-routed to the slop tank for additional treatment. Table 4.2-7 presents a typical profile for the hazardous deck drains from the FLNGVs.

Nonhazardous deck drains would include those draining storm water over deck areas where oil or grease sources are not a concern. As a precaution for any intermittent oil or grease residuals, the first-flush principle or the first one-half inch of rainfall would be diverted to the slop tank for treatment. Remaining storm water from these areas would be directly discharged overboard to the sea via deck drains and storm water conveyance pipes.

Table 4.2-7. Hazardous Deck Drains Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Hazardous Deck Drains	Slop Tanks	Intermittent	Biochemical Oxygen Demand (BOD)	10.0
			Chemical Oxygen Demand (COD)	75.0
			Total Organic Carbon (TOC)	20.0
			Total Suspended Solids (TSS)	10.0
			Ammonia (N)	40.0
			Winter Temperature (°F)	85
			Summer Temperature (°F)	90
			Total Residual Chlorine a/	0.5
			Copper (µg/L) a/	2.0
			pH	6-9
			Oil and Grease	15.0

Notes:
a/ Concentration shown is the dose administered for effect biofouling control and due to organic complexation and scavenging would be lower when finally discharged.
Key:
°F = degrees Fahrenheit; µg/L = microgram per liter; mg/L = milligram per liter

Cooling Water

The FLNGVs would rely on air-cooled heat exchangers for their main power plant cooling processes, thus abating the need for use of seawater for cooling water via a main cooling water condenser system. However, each FLNGV would be equipped with essential generators as back-up systems for basic support needs that would rely on seawater withdrawal for cooling purposes in the event of an emergency. During regular operations, these backup systems would only be run intermittently for system testing and would withdraw volumes of 600 gpm, approximately every two weeks. The essential generators would only be used on a continuous basis if the FLNGVs needed to disconnect and leave the proposed Port to avoid a forecasted hurricane, significant storm event, or other unique circumstances. Under these conditions, the FLNGVs would be considered as an underway marine vessel and not a stationary discharge. Given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1 degree Fahrenheit (°F) or less within 328 ft (100 m) from the discharge source (see Appendix N). The ambient seawater temperature at the proposed FLNGV platform site ranges from 62 to 87°F. Table 4.2-8 presents a typical discharge characteristic profile for the FLNGV cooling water discharge.

Because the FLNGVs and the platform would be located in Federal waters, temperature criteria for Federal waters would be subject to USEPA ambient water quality criteria. For the protection of characteristic indigenous marine communities from adverse thermal effects, the USEPA recommends that the maximum acceptable increase in the weekly average temperature resulting from artificial sources is 1 degree Celsius (°C) (1.8°F) during all seasons of the year, provided the summer maxima are not exceeded (USEPA 1986). Based on the anticipated testing schedule to be limited to a single 30-minute test every two weeks, a rise of only 0.5°C (1°F) would be in compliance with the USEPA standard, thus any thermal impact would be de minimis during such testing operations. For coastal waters, the LDEQ lists that maximum water temperatures may not exceed a maximum temperature of 35°C (95.0°F).[24] Based on this

[24] http://www.deq.louisiana.gov/portal/Portals/0/planning/regs/title33/33v09-201512%20Water%20Quality%202a.pdf

standard, the low delta T associated with the testing period is not expected to cause exceedance of this standard, and therefore the associated thermal impacts are considered minor.

Table 4.2-8. Essential Generator Cooling Water Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Cooling Water	Seawater	Intermittent	Biochemical Oxygen Demand (BOD)	0.8
			Chemical Oxygen Demand (COD)	1.0
			Total Organic Carbon (TOC)	2.5
			Total Suspended Solids (TSS)	25.0
			Ammonia (N)	0.02
			Winter Temperature (°F)	75.0
			Summer Temperature (°F)	88.0
			Total Residual Chlorine (mg/L) a/	0.5
			Copper (μg/L) b/	2.0
			pH	8

Notes:
a/ Maximum dose applied at water intake
b/ For routine dosing for coating inside of pipe
Key:
F = Fahrenheit; μg/L = micrograms per liter; mg/L = milligram per liter

The FLNGV cooling water systems for the essential generators would be treated for macrofouling control with an on-board chlorine system and a copper-aluminum anode system. These systems would introduce both chlorine and copper into the cooling water systems after entrance into the sea chest. Both macrofouling agents would undergo consumptive processes within the water intake system. Discharge concentrations of both agents are expected to be below dosing concentrations and be within effluent limits dictated in the NPDES permit. Therefore, associated water impacts are expected to be compliant with Federal regulations and represent a long-term negligible, adverse impact on the receiving waters of the Gulf of Mexico.

Reverse Osmosis Reject Water

Freshwater utility and potable supplies would be provided by freshwater generators onboard the FLNGVs. The primary system to be used for freshwater generation would be an RO system. Table 4.2-9 presents a typical anticipated discharge characteristic from the RO system. This system would be a continuous discharge from each of the FLNGVs. Salinity at the proposed Project location, as monitored by ambient sampling, found surface salinities to range 32.0 to 34.0 parts per thousand (ppth) at the proposed platform location by Delfin LNG in December 2015. The brine flow discharge rate would be approximately 444 gpm or 0.638 mgd, with a salinity concentration in the brine of 35 to 55 ppth at discharge without mixing in the water column. CORMIX modeling of the RO discharge predicted the higher density brine plume to be negatively buoyant and sink following discharge (see Appendix N). Salinity of the dilution from the RO unit was predicted to dissipate to near ambient salinity levels at 100 m from the discharge port. Salinity of the brine discharge at the outlet port was modeled based on a discharge salinity of 55 ppth. Plume dilution within the regulatory mixing zone determined that near ambient salinity is attained 100 m from the discharge port. CORMIX modeling revealed ambient conditions at the edge of the regulatory mixing zone. See Sections 4.3.6.2, 4.3.7.2, and 4.3.8.2 for a discussion of the impacts of the RO plume on biological resources.

Table 4.2-9. Reverse Osmosis Reject Water Discharge Characteristics for FLNGVs

Overboard Discharge	Source Description	Flow Period	Parameter	Average Daily Value (mg/L or as noted)
Reverse Osmosis Reject Water	Reverse Osmosis Plant Brine	Continuous	Chemical Oxygen Demand (COD)	10.0
			Total Organic Carbon (TOC)	8.0
			Total Suspended Solids (TSS)	300.0
			Ammonia (N)	4.0
			Winter Temperature (°F)	85.0
			Summer Temperature (°F)	90.0
			Total Residual Chlorine a/	0.5
			pH	6-9

Notes:
a/ Concentration shown is the dose administered for effect biofouling control and due to organic complexation and scavenging would be lower when finally discharged.
Key:
F = Fahrenheit; μg/L = micrograms per liter; mg/L = milligram per liter

Accidental Releases of Fuel, Oil, and Other Chemicals

Some areas of the proposed Project may be subject to potential spill-related incidents during startup and operation of each FLNGV. Specifically, this includes spills of hazardous materials at the storage tanks/containers, hazardous material loading/unloading areas, and spills from equipment (e.g., hydraulic leaks, fuel spills). If bulk deliveries of a hazardous material are to be received on-site or to operational vessels moored at the construction site, then adequate preparation would be used, including training, proper personal protective equipment, and temporary evacuations of personnel working near the delivery area.

Vessels associated with service and supply operations would be equipped with spill containment and cleanup equipment to respond to small, accidental releases of bunkers, lubricants, or other chemicals. In the event of a large spill, an emergency response would be mobilized from shore. Impacts associated with these activities would be avoided or minimized by protective measures developed in an SPCC Plan and FRP.

Delfin LNG prepared an Emergency Response Manual (Appendix K) to outline initial response activities that would be complete during an onsite emergency. The Emergency Response Manual contains provisions that comply with USCG and U.S. Department of Transportation (DOT) requirements (33 CFR Part 127.307) and identifies LNG release response procedures; emergency shutdown procedures; telephone numbers of local USCG units and other emergency responders; location and provisions of any personnel shelters; first aid procedures; and emergency procedures for mooring and unmooring a vessel. The Emergency Response Manual also contains a list of chemicals and lubricants onboard each FLNGV.

The FRP would describe measures to be implemented by Project personnel and contractors to prevent and, if necessary, control any inadvertent spill of hazardous materials (e.g., fuels, lubricants, and solvents) that could affect water quality. The FRP would identify typical fuel, lubricants, and hazardous materials stored or used, and the location, quantity, and method of storage. The FRP would also describe the preventive and mitigation measures to be taken to avoid or minimize impacts of spills of fuels, lubricants, or hazardous materials. Additionally, the FRP would identify emergency notification procedures in the event of a spill. In the event of a spill, procedures for collection and disposal of waste generated during spill cleanup or equipment maintenance would also be defined. This general FRP would be updated with site-specific information prior to construction. All hazardous materials would be handled in accordance with the FRP. The Project-specific FRP would be prepared during the Front-End Engineering Design process.

A Spill Response Plan would be prepared for the proposed Port in accordance with requirements specified in 33 CFR Part 154.1030 to address port-specific spill response measures for oil and in 33 CFR Part 127 to address natural gas discharge. The purpose of the Spill Response Plan is to provide clear guidance and procedures for the response, control and containment of any accidental releases or spills. This includes spills of hazardous materials at the storage tanks/containers, hazardous material loading/unloading areas, and spills from equipment (e.g., hydraulic leaks, fuel spills). If bulk deliveries of a hazardous material are to be received on site, then adequate preparation would be used, including training, proper personal protective equipment, and temporary evacuations of personnel working near the delivery area. Except for marine diesel oil, all other chemicals would be brought to the FLNGVs in International Standards Organization (ISO) containers or drums.

The proposed Port would include ship refueling capability (fuel oil and diesel oil) and supplies for provisioning vessels and helicopters, but quantities would be limited. Also, limited fuels (such as diesel) for support craft would be stored on the proposed Port for its own use during startup and emergency situations. On a regional basis, oil spills from the proposed Port releases are expected to be minimal because of the small quantities to be stored there. A spill from the proposed Port would be expected to produce adverse but short-term and minor impacts on water quality.

Daily operations on board the FLNGVs would require routine maintenance and upkeep that could involve contact with machinery fluids both as part of replacement or refilling as needed. Equipment that has the potential to release hydrocarbons would be designed to include drain pans to capture any released hydrocarbons and rainwater. The open drain system would collect rainwater, wash water, and other fluids, which would be pumped or gravity drained to slop tanks. Two slop tanks have been provided in series to treat oily water by gravity separation. Treated water meeting Federal requirements would be discharged to the Gulf of Mexico through an outfall pipe located below water level. Free oil collected at the top of the water layer would be removed using floating oil skimmers and routed to an oil/sludge collection tank. Oily sludge collected in the slop tanks would be routed to a hydrocyclone for separation of oil and solids. Treated water would be discharged to the sea if it contains less than 15 ppm of oil or per NPDES permitted effluent standards. An oil-water separator alarm monitor would be used on the FLNGVs to ensure compliance with the oil content regulatory requirements of 15 ppm.

If the oil content is higher than 15 ppm, the water would be re-routed to the slop tank for treatment. The deck area around the liquefaction section would be curbed, and any accidental LNG or refrigerant spill would be routed to an ISO storage container for shipment to shore for treatment. Open areas of the proposed Port not subject to hydrocarbon spills (e.g., around the crew quarters) would drain overboard. The open drain system described above would effectively prevent impacts on water quality such as hydrocarbon or chemical spills by collecting rainwater, wash water, or other fluids subject to hydrocarbon contamination and pumping them to the oily water treatment system.

LNG Spills

Short-term, minor, direct adverse impacts on water quality could occur in the unlikely event of an LNG spill. All FLNGVs are designed with features to minimize the potential for LNG spills (see Section 2.2.10.1). However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in rapidly dropping water temperatures near the surface. These impacts would likely occur in the immediate vicinity of the spill location; the time frame of the impact is limited (see Section 5). Since LNG would boil off as natural gas at the surface, depth and pressure required for gas to dissolve (Artemov et al. 2005) in surface waters would not be sufficient and gas vapors would disperse. In addition, the time frame for these impacts would be limited, and adverse toxic impacts would be expected to be minor after the LNG boiled off and the vapors dispersed.

The potential for a release of natural gas from the proposed pipeline and laterals is remote. The proposed pipeline laterals and WC 167 Bypass would be buried or covered before proposed Port operations commence, making damage to the pipeline resulting in leaks less likely. Other than the unlikely event of a pipe leak or rupture, operation of the proposed pipelines are not expected to create environmental disturbances. While Patin (1999) suggests that increased dissolved gas levels in the water column during the sudden release of natural gas (methane) into the marine environment may raise to toxic levels; however, further study is needed. Dissolution of natural gas into the marine environment is known to occur naturally from seeps and from methane hydrates and contributes to higher methane concentrations in some regions of the earth's marine environment. These are typically more gradual releases of methane, occurring over an extended period of time, with finer bubble sizes ranging from 0.04 to 0.4 inches and typically at greater depths (greater than 295 ft), pressures and lower temperatures than those along the existing UTOS/HIOS pipeline system, and proposed WC 167 bypass and pipeline laterals. Smaller bubble sizes and greater depths and pressures contribute to more gas being dissolved and less gas (calculated at approximately 18 percent at approximately 295 ft) reaching the surface for atmospheric dispersion (Artemov et al. 2005). In general, whether a release is sudden or extended, physics dictate that any methane would gradually dissolve into the water column during the lifetime of the bubble as described by Fick's law, taking into account Henry's law constants, partial pressure and concentrations of dissolved gases (Artemov et al. 2005). Once a gas bubble reaches the surface, it would rise (being lighter than air) and be dispersed by air currents. If a subsea release of natural gas occurs, the limited quantity of gas released would rise to the water surface rapidly and would dissipate. Natural gas is non-toxic to the atmospheric environment. Any localized increase of natural gas concentration in the water column would be short-term, minor, and would dissipate with time and distance.

4.2.3 Impacts of Decommissioning

Short-term, direct, minor, adverse impacts on water quality are expected in connection with decommissioning of the proposed Port. The proposed Port is designed for a 30-year service life. Decommissioning would involve the removal of all aboveground structures and leaving in place facilities such as the pipeline and bypass structures abandoned in place a minimum of 3 ft below the marine bottom. Decommissioning of the proposed pipelines facilities would consist of purging the pipe of gas, pigging, and filling it with seawater. BOEM (30 CFR Ch. II S250.1728) states that all pilings and associated platform structures must be removed to at least 15 ft below the mudline unless the BOEM Regional Supervisor approves an alternate depth as per 30 CFR Ch. II S250.1728. These activities would result in the disturbance of shallow sediments and result in localized increases in turbidity and TSS in the water column during on bottom or near bottom area during removal operations. Increased marine vessel activity associated this effort would also result in the temporary, minor impacts on water quality from discharges of vessel process water and ballast water to the local environment during decommissioning operations. These discharges would be confined to the period of decommissioning and would have short-term, minor impacts on water quality.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on water resources, including analysis of sediment characteristics, would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.2.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.2.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to the Maritime Administration (MARAD) or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore water resources.

4.2.4.2 Alternative Deepwater Port Designs

Use of alternative deepwater port designs may influence the duration or extent of impacts on water resources during construction, operation, and decommissioning. Water usage would be dependent on the type of specific systems that would be selected for each alternative, as well as the number and type of support vessels required for operations. Installation of a fixed platform-based unit would result in additional seafloor disturbance. Other alterative deepwater port designs would result in similar impacts on water resources.

4.2.4.3 Alternative Cooling Media

The proposed Port currently uses air-based cooling systems that require greater space on board the FLNGVs than traditional open-loop, once-through cooling water systems for a water-based condenser cooling process. Water withdrawal demands for cooling using the air-based cooling system design would be limited to emergency generator testing for each of the FLNGVs and would be based on only periodic testing durations under routine FLNGV operations (a withdrawal of approximately 18,000 gallons every two weeks). If a seawater-based open-loop cooling water system were to be used, seawater intake would increase to between 72 to 290 Mgal of seawater per day, per FLNGV, and result in greater thermal signatures in receiving waters of the Gulf of Mexico and greater impacts on the entrainment of ichthyoplankton. Given the extent of the associated impacts from thermal loading and entrainment with a once-through, open loop cooling water system across four FLNGVs, the use of seawater as the primary cooling media would have greater impacts than the air-based cooling system. Therefore, the air-based cooling system is the Applicant's proposed alternative.

4.2.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore water resources associated with use of this alternative because the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.2.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Construction equipment and duration would be the same for each of the alternative locations. However, Alternative 3 would be located in waters that average a depth of about 80 ft, and Alternative 2 would be located in waters that average a depth of about 73 ft versus Alternative 1 that averages about 66 ft. This additional depth could result in increased turbidity and sediment transport depending on the type of anchor system used for port structures (e.g., anchor chain movements as a result of the greater sweep area).

4.2.4.6 Alternative Anchoring Systems

Four other anchoring alternatives were evaluated for securing the TYMS to the sea bottom, as discussed in Section 2.3.8. These alternatives included the use of grouted piles, suction piles, gravity anchors, and embedment anchors. Like driven piles, grouted and suction pile–based structures rely on the insertion of vertical fixed pilings into the seafloor, while anchor-based systems use tethered anchors that rely on sheer mass and gravity, or being driven into the sub-seafloor, to secure floating structures to the sea bottom. From an engineering design standpoint, the type of soils or substrate is usually the major deciding factor in determining the most suitable structure for securing the TYMS in place.

Suction piles are installed on the seafloor and drawn into the soft sediments by lowering the pressure beneath the advancing piling form. They require a minimum of 25 ft of surficial substrates. Water quality impacts from this technology include generation of increased levels of turbidity and TSS concentrations above natural ambient concentrations during installation due largely to disturbance of surface sediments. Additionally, suction piles may not represent an effective engineering solution for securing the TYMS to the seafloor due to their limitations in depth of sub-sediment penetration. This potential lack of adequate soil penetration can result in corresponding limitations in restraining the TYMS structure from large wave or swell-induced overturning moments.

Grouted pilings are drilled holes in the seabed that have pipe installed and possibly cemented or have concrete or grout poured into the drilled hole. This piling type is difficult to install and potentially unstable in soft or loose substrates. Grouted piles are very difficult to recover during decommissioning and are typically cut beneath the sediment surface and abandoned in place. Like other piling methods, localized increases in turbidity and TSS concentrations can be expected during construction from piling installation disturbance of the sea floor. Localized current induced scouring around the piling bases may also contribute to these increases though some degree of scour would allow for particle size sorting and settling around the piling base.

Fluke anchors are typically steel structure with some sort of anchor referred to as a hook or fluke. They derive their holding power from hooking or embedding in the bottom, with a secondary reliance on their mass, and can be used in a wide range of soil types. Installation involves dragging an anchor with heavy pull service vessels to embed them in the soil. Where fluke anchors are used, special attention must be paid to anchor positioning and tensioning. When used in soft sediments, these anchors are dragged down into the sediments and their holding capacity is dependent upon the subsequent level of tensioning. Water quality impacts from this technology include generation of increased levels of turbidity and TSS concentrations above natural ambient concentrations during installation due largely to disturbance of surface sediments. Fluke anchors may not represent an effective engineering solution for securing the TYMS to the seafloor due to their limitations restraining structures from large wave or swell-induced overturning moments. During decommissioning, fluke anchors are recoverable.

Gravity anchors are massive concrete objects (consisting of a series of connected concrete blocks) that provide a stable anchor by their weight and the friction between the dead weight and the seabed. Gravity anchors do not represent an effective engineering solution for securing the TYMS to the seafloor due to their limitations in restraining the TYMS structure from large overturning moments. Similarly, embedment anchors do not represent an effective engineering solution for securing the TYMS to the seafloor due to their limitations in restraining the TYMS structure from large overturning moments as well. Both systems would generate short-term increases in near-bottom turbidity and TSS concentrations from placement and sustained localized scour around the anchors after placement. Some degree of equilibrium would be attained after a post-construction duration where bottom substrates would scour to particle sizes resistant to localized current sheer forces.

4.2.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-2:** All Project-related activities will comply with Federal regulations to control the discharge of operational wastes such as bilge and ballast waters, trash and debris, and sanitary and domestic waste generated from vessels associated with the proposed Project.
- **BMP-3:** Delfin LNG will adhere to the Project-specific plans as well as other Federal and State permit requirements including the USACE Nationwide Permit 12.
- **BMP-4:** Prior to construction and operation, Delfin LNG will prepare and submit for approval a construction and operation SPCC Plan and FRP detailing emergency procedures for addressing accidental releases and spills during construction and releases.
- **BMP-5:** All construction vessels will operate in accordance with SPCC plans. All vessels will have spill containment kits and spill response plans for use in the event of a release. Typically, a spill response kit for a vessel other than an oil carrier must be capable of cleaning up an on-deck spill of a half-barrel or less.
- **BMP-6:** Delfin LNG will provide a hydrostatic test plan for approval by the USCG prior to any hydrostatic testing of pipelines. Delfin LNG does not currently plan on using a dye as part of hydrostatic testing; however, if subsequent design work should call for the use of a dye as part of hydrostatic testing, Delfin LNG would use an USEPA-approved dye.
- **BMP-7:** Delfin LNG will test the discharge water from the hydrostatic testing of the UTOS and HIOS pipeline systems for the presence of hydrocarbons, including the use of the USEPA's "visible sheen test." Delfin LNG will filter the hydrostatic discharge water sufficiently in order to meet the requirements of the general permit governing hydrostatic testing operations in the Gulf of Mexico.
- **BMP-8:** Delfin LNG will design the FLNGVs such that equipment on the main deck with the potential to release hydrocarbons is installed above drain/drip pains or within contained areas that would collect rainwater, wash water, and other fluids, which would be pumped or gravity drained to slop tanks.
- **BMP-9:** Delfin LNG will use the first-flush principal for rainwater collection and treatment.
- **BMP-10:** While ambient levels of contaminants were found to be low and the potential for introduction of toxic substances into the water column appear negligible, increases in turbidity may be measurable and require monitoring to ensure compliance with marine water standards. These standards would be established as part of the permitting process.
- **BMP-11:** A turbidity/suspended sediment monitoring program may be implemented to provide data on ambient bed load contribution to the water column during piling installation. This program will be analogous with what is required for offshore oil and gas exploration and production in the Gulf of Mexico.

- **BMP-12:** Delfin LNG will acquire the appropriate individual or project-based NPDES permits for the continuous and intermittent discharges for the various on-board service systems. The NPDES permit will be administered by the USEPA for Federal waters and will require periodic monitoring for compliance under the CWA. The NPDES permits will establish set standards for individual chemical constituents in effluent discharges based on receiving water resource value and quality and established numerical water quality criteria. Continuous discharges will include sanitary, reverse osmosis, bilge, and ballast water from the four FLNVGs. In addition to these permanent discharges, intermittent discharges will also require monitoring as part of the NPDES permit. Similar discharges from the calling LNGCs at the proposed Port will also occur. Compliance monitoring of individual constituents in the discharges will vary and methods for monitoring may include inline electronic monitoring or direct effluent sampling for laboratory analysis. Compliance will be reported based on frequency of monitoring and established regulatory requirements as part of required discharge monitoring reporting in the NPDES permit. All associated discharges from the FLNGVs and LNGCs will be managed under the NPDES permit. Frequency of reporting and compliance will be required as part of the permitting reporting process. Unique or variable effluents may require WET to determine compliance for mixed constituent effluents. Additional BMPs may be established for monitoring and sampling frequency for NPDES compliance monitoring for the FLNGVs.
- **BMP-13:** LNGCs calling on the proposed Port will be required to use approved equipment and follow and maintain records for ballast water and operational discharges (e.g., bilge, sanitary discharges) that are compliant with MARPOL and USCG standards. LNGCs operating fully within Federal waters will be required to operate under a Vessel General Permit. Inspections will require review of onboard records for assessing compliance.

4.2.6 Recommendations and Conclusions

Impacts on offshore water resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.2-10.

Table 4.2-10. Summary of Impacts for Offshore Water Resources

Aspects of Proposed Action With Potential to Affect Resource	Amount/ Frequency	Applicable Best Management Practices	Potential Effect
Construction			
Construction of mooring platforms, pipeline laterals, and WC 167 bypass	Occasional disturbance of water quality during the 5.5-year construction period	BMP-10; BMP-11	Negligible
Hydrostatic testing	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Negligible
Accidental spills and releases	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, minor, adverse
Pipeline operations including pigging	During port operation	BMP-10; BMP-11	Negligible

Table 4.2-10. Summary of Impacts for Offshore Water Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Amount/ Frequency	Applicable Best Management Practices	Severity of Effect
Operation			
FLNGV operational withdrawals and discharges, including desalination system, water curtain and firewater pump testing	During port operation – see Tables 4.2-1 and 4.2-2	BMP-12; BMP-13	Negligible
Ballast water intake and discharge	Intake: 18,000,000 gallons per off-take cycle per FLNGV with 40 off-takes per a 336-day production year Discharge: 1,690 gpm per FLNGV continuously (7.4 of every 8.4 days)	BMP-12; BMP-13	Long-term, minor, adverse
Bilge water discharge	During port operation	BMP-12; BMP-13	Negligible
Scrubber water discharge	During port operation	BMP-12; BMP-13	Negligible
Sanitary discharge	10-40 gpm per FLNGV, continuously	BMP-12; BMP-13	Long-term, minor, adverse
Hazardous and non-hazardous deck drains	During port operation	BMP-12; BMP-13	Negligible
Cooling water for essential generators	600 gpm, occurs for 30 minutes once every two weeks per FLNGV	BMP-2	Negligible
Reverse osmosis reject water	During port operation	BMP-12; BMP-13	Long-term, moderate, adverse within the regulatory mixing zone
Accidental releases of fuel, oil, and other chemicals	Unlikely, but possible during port operations	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, minor, adverse
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on water resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.3 Offshore Biological Resources

This section addresses potential impacts on offshore biological resources associated with the proposed Project and alternatives. The biological resources potentially affected by the proposed Project are described in Section 3.2 and include benthic resources, plankton (including ichthyoplankton), fisheries, non-endangered marine mammals, and coastal, marine, and migratory birds. As discussed in Section 3.3.5, and in accordance with Section 7(c)(1) of the Endangered Species Act (ESA) and Section 102 of NEPA, this EIS would serve as the Biological Assessment (BA) for the Proposed Action. Please refer to Section 2.2 for a detailed description of the Proposed Action.

The sections that follow provide impact analyses for Delfin LNG's proposed site on offshore biological resources, including benthic resources, plankton, fish, marine mammals, sea turtles, birds, and marine protected areas. The section concludes with a comparison of impacts for Delfin LNG's alternative deepwater port design, alternative cooling media, and alternative anchoring media. BMPs are also discussed.

4.3.1 Offshore Threatened and Endangered Species

Activities associated with construction and operation of the proposed Project that may impact threatened and endangered species include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC operational intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- water intake associated with FLNGV commissioning;
- noise from construction, operation, and decommissioning activities;
- anchoring;
- artificial lighting;
- increased vessel traffic;
- marine debris;
- periodic pipeline maintenance; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

The ESA defines “endangered” as a species in danger of extinction in all or a significant portion of its range. “Threatened” is then defined as a species that is likely to become endangered in the foreseeable future. If a Federal agency undertakes an activity that may impact an “endangered” or “threatened” species, they must first consult with the USFWS or NOAA Fisheries, or both, according to Section 7 of the ESA. As defined in Section 3.3.5, the Action Area is defined as all areas that may be affected directly or indirectly by the Federal action. It includes not only the immediate area involved in the proposed action but encompasses the geographic extent of environmental changes (i.e., the physical, chemical, and biotic effects) that would result directly and indirectly from the action. Effects from actions in the proposed Port or in the Economic Exclusion Zone (EEZ) waters for the approach routes of the LNGCs, as detailed below can be either direct or immediate (direct effects) on the species or on its habitat, or indirect, that is effects caused by or that would result from the proposed action which would occur later in time or as a secondary effect of the direct impacts, but still reasonably certain to occur (50 CFR 402.02). An effect determination is made for each listed species and designated critical habitat. According to the following determinations:

- No Effect – literally no effect whatsoever to the listed species or designated critical habitat.
- May Affect, Not Likely to Adversely Affect – effects to the listed species or designated critical habitat that are insignificant, discountable, or wholly beneficial. “Insignificant” impacts are those that do not rise to the level of take. “Discountable” impacts are those that are very unlikely to occur. “Wholly beneficial” effects must have no short- or long-term adverse impacts.
- Likely to Adversely Affect – effects will result in a short- or long-term incidental take of the listed species or designated critical habitat.

The sections that follow provide impact analyses for Delfin LNG’s proposed site on threatened and endangered species, and identifies the activities that may affect, or are not likely to adversely affect (Table 4.3-1) one or more threatened and endangered marine species (marine mammals, sea turtles, fish and birds) as defined in Section 3.3.5. Most recent correspondence with NOAA Fisheries indicates that concurrence with the determination made in this final EIS that the proposed offshore activities are not likely to adversely affect Federally listed species is under review. The receipt of a NOAA Fisheries concurrence letter on the final EIS findings for Federally listed species will be included as a condition of the Record of Decision. The section below concludes with a comparison of impacts for Delfin LNG’s alternative deepwater port design, alternative cooling media, and alternative anchoring media. BMPs are also discussed.

Table 4.3-1. Impact Assessment Summary for Federal Threatened and Endangered Species in the ROI (Offshore)

Common Name	Scientific Name	Occurrence within the EEZ	Occurrence in the Proposed Port Location	ESA and MMPA Status	Impact Determination for Proposed Project	Impact Determination for Alternatives
Marine Mammals						
Sei Whale	*Balaenoptera borealis*	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Blue Whale	*Balaenoptera musculus*	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Fin Whale	*Balaenoptera physalus*	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Northern Right Whale	*Eubalaena glacialis*	Unlikely / rare	Unlikely / rare	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Humpback Whale	*Megaptera novaeangliae*	Potential (common in the Gulf of Mexico though less so in the Northern portion)	Unlikely / rare	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Sperm whale	*Physeter macrocephalus*	Likely	Unlikely, prefers deeper waters	ESA Endangered/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Bryde's whale	*Balaenoptera brydei*	Likely	Unlikely, prefers deeper waters	ESA Candidate/ MMPA	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Sea Turtles						
Hawksbill turtle	*Eretmochelys imbricata*	Likely	Likely (seasonal)	Endangered	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Kemp's ridley turtle	*Lepidochelys kempii*	Likely	Likely (Abundant, seasonal)	Endangered	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Table 4.3-1. Impact Assessment Summary for Federal Threatened and Endangered Species in the ROI (Offshore) (continued)

Common Name	Scientific Name	Occurrence within the EEZ	Occurrence in the Proposed Port Location	ESA and MMPA Status	Impact Determination for Proposed Project	Impact Determination for Alternatives
Loggerhead turtle a/	*Caretta*	Likely	Likely (Abundant, seasonal)	Threatened	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Green turtle	*Chelonia mydas*	Likely	Likely (Abundant, seasonal)	Threatened	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Leatherback turtle	*Dermochelys coriacea*	Likely	Likely (Abundant, seasonal)	Endangered	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Marine Fish						
Smalltooth sawfish	*Pristis pectinata*	Unlikely	Unlikely	Endangered	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Gulf sturgeon	*Acipencer oxyrinchus*	Unlikely, seasonal	Unlikely, seasonal	Endangered	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Note:
a/ Proposed Project activities may affect, not likely to adversely affect critical habitat for this species.

4.3.1.1 Threatened and Endangered Marine Mammals

As discussed in Section 3.3.5.1, there are six Federally listed (ESA protected) and one ESA candidate large whale marine mammal species with the potential to be found in the overall Action Area. None are expected to occur in the proposed Port location; therefore, there would be no effect from construction, operation, or decommissioning activities at or in the vicinity of the proposed Port. However, if these species occur within the EEZ where LNGCs would transit, there still remains the potential for ship strikes.

Five of the ESA-listed species (the baleen whale species) could occur and have the potential to be found within the EEZ waters. The sperm whale is the only ESA-listed species that that is likely to occur and expected to be collocated in the EEZ waters that are along the proposed LNGC transit routes, while the other five species of endangered baleen whales are rare in northern Gulf of Mexico waters (BOEM 2011a). The Bryde's whale population, a candidate species for ESA listing (the Gulf of Mexico Distinct Population Segment [DPS]), also could occur within the EEZ waters.

While the northern right whale has been historically sighted in the northern and western portions of the Gulf of Mexico, this species would be unlikely/rare in both the EEZ and the proposed Port, since the species is considered critically endangered and also is susceptible to vessel strike and entanglement, injury or death of even one individual would be considered a major population impact due to its small population size; therefore, any vessel-related impacts on right whales, while unlikely, would not be mitigatable. The sperm whale is the only ESA-listed whale that is known to commonly occur in the northern Gulf of Mexico and may be considered a resident species, while the other five species of endangered baleen whales are rare in northern Gulf of Mexico waters (BOEM 2011a). However, there are no species of whales that commonly occur in the nearshore shelf waters of the Gulf of Mexico (NOAA Fisheries 2012a) where the proposed Port would be located (Table 4.3-1), and there is no critical habitat designated for marine mammals in the Gulf of Mexico.

Impacts of Construction

Construction activities are described in Section 2.2.9. Most proposed Project-related construction activities and their associated impacts, including disturbance of benthic habitat, construction-related turbidity, construction support vessel intake and discharge, hydrostatic test water discharge, and FLNGV commissioning, would likely be local to the proposed Port location, and thus be out of range of ESA-listed marine mammals. Construction-related vessel traffic would transit from the coast to the proposed Port site, and thus, these vessels, including routine discharges from construction vessels and accidental releases of fuel, oil, and other chemicals from construction vessels, would also be unlikely to overlap with ESA-listed marine mammals. Effects from these construction activities are eliminated from further analysis with respect to ESA-listed marine mammals; however, they are evaluated for non-ESA-listed marine mammals in Section 4.3.3. Pile driving at the proposed Port site could ensonify areas outside of the proposed Port location where ESA-listed marine mammals could occur; thus, potential effects from construction noise are evaluated.

Noise

NOAA Fisheries has currently established underwater noise thresholds for injury and behavioral disturbance. Acoustic ZOIs for potential injury and behavioral disturbance thresholds were calculated based on mitigated source levels for impact-driven, 78-inch steel pipe piling within an air bubble-infused cofferdam. Affected area radii representing potential behavioral and injurious effects to fish and marine mammals were calculated based on NOAA Fisheries (2016b) acoustic criteria for marine mammals. It is important to note that the NOAA Fisheries (2016b) acoustic criteria for marine mammals provide updated acoustic thresholds for the onset of permanent threshold shift (PTS), which is considered an auditory injury, and temporary threshold shift (TTS), which is not considered an auditory injury but is considered an adverse effect and “harassment” under the Marine Mammal Protection Act (MMPA). Acoustic thresholds for the onset of behavioral effects have not been updated by NOAA Fisheries, and so the acoustic threshold for TTS onset is used here as a proxy for behavioral disturbance threshold and ZOI. In addition to the evaluation below, Section 4.10 contains more details about noise and modeling methodology.

Sound is a key component of survival for many marine mammal species. It is used for various components of daily survival such as foraging, navigation, and predator avoidance. It is also thought that marine mammals use sound to learn about their surrounding environment, gathering information from both natural sources (such as inter- and intra-specific species), or naturally occurring phenomenon such as wind, waves, rain, or naturally occurring seismic activity (i.e., earthquakes) (Richardson et al. 1995). With a global increase in human-generated sound in the water column, marine organisms may be affected by exposure to such noise behaviorally, acoustically, and/or physiologically (Richardson et al. 1995).

Behavioral reactions can include a flight response, changes in breathing and diving patterns, avoidance of important habitat or migration areas, and a disruption of social relationships and interactions (Richardson et al. 1995; Nowacek et al. 2007; McCauley et al. 2000). Acoustic responses from marine mammals can include masking, changes in call rates, and changes in call frequency (Southall et al. 2007; Richardson et al. 1995; Nowacek et al. 2007). Masking is a decreased ability of an animal to detect relevant sounds due to an increase in background noise that effectively blocks those sounds. Physiological responses can include TTS, PTS, increased stress levels, and direct or indirect tissue damage (Richardson et al. 1995; Southall et al. 2007; Wright et al. 2007). TTS is the temporary, fully recoverable reduction in hearing sensitivity due to exposure to greater-than-normal sound intensity. PTS is a permanent, non-recoverable reduction in hearing sensitivity due to damage caused by either a prolonged exposure to a sound or temporary exposure to a very intense sound. When or how a marine animal responds to a sound depends on numerous variables such as the characteristics of the sound itself, characteristics of the animal (age, sex, habitat), and previous exposure to the sound of concern or other sounds (Wartzok et al. 2004).

To estimate noise threshold distances produced from impact pile-driving activities during construction of the mooring platforms, the transmission loss constant was assumed to be 15, and background noise levels from were assumed to peak near 150 decibels (dB) from vessel transits through the safety fairways that serve the Ports of Galveston, Port Arthur, Beaumont, Orange, and Lake Charles (CSA 2016). The distance to established thresholds (i.e., ZOIs), based on a conservative approach using measured noise levels from a relevant study (Benicia-Martinez Bridge; see Section 4.10.1.3) are approximately 1,088 m, 38.7 m, and 1,296 m for the Level A noise injury thresholds for low, middle, and high frequency cetaceans, respectively. For the marine mammal noise disturbance threshold of 160 dB (Table 4.3-2; Figure 4.3-1), the estimated distance was 857 m. Distances to the TTS cetacean thresholds are 10,887 m, 387.2 m, and 12,969 m for low, middle, and high frequency cetaceans, respectively. For both of these threshold distance estimates, cofferdam and bubble curtain mitigation measures have been proposed for reducing sound levels. Additionally, large cetacean occurrence in the proposed Port location is unlikely, although smaller marine mammals (dolphin) are possible. No distinct marine mammal foraging habitat has been identified in the vicinity of the proposed Port location.

Table 4.3-2. Threshold Levels Used to Determine the Zone of Influence Radii for Cetaceans

Threshold Criteria		Low-Frequency Cetacean Thresholds	Mid-Frequency Cetacean Thresholds	High-Frequency Cetacean Thresholds
Type	Units			
Permanent Threshold Shift	cSEL (dB re 1 μPa^2•s)	183	185	155
	SPL_{pk} (dB re 1 μPa)	219	230	202
Temporary Threshold Shift	cSEL (dB re 1 μPa^2•s)	168	170	140
	SPL_{pk} (dB re 1 μPa)	213	224	196
Behavioral	$SPL_{rms90\%}$ (dB re 1 μPa)	160		

Key:
SEL = sound exposure level
SPL_{pk} = peak sound pressure level
SPL_{rms90} = root mean square (90%) sound pressure level
dB re 1 μPa = decibels relative to 1 microPascal
dB re 1 μPa
Source: NOAA Fisheries (2016b)

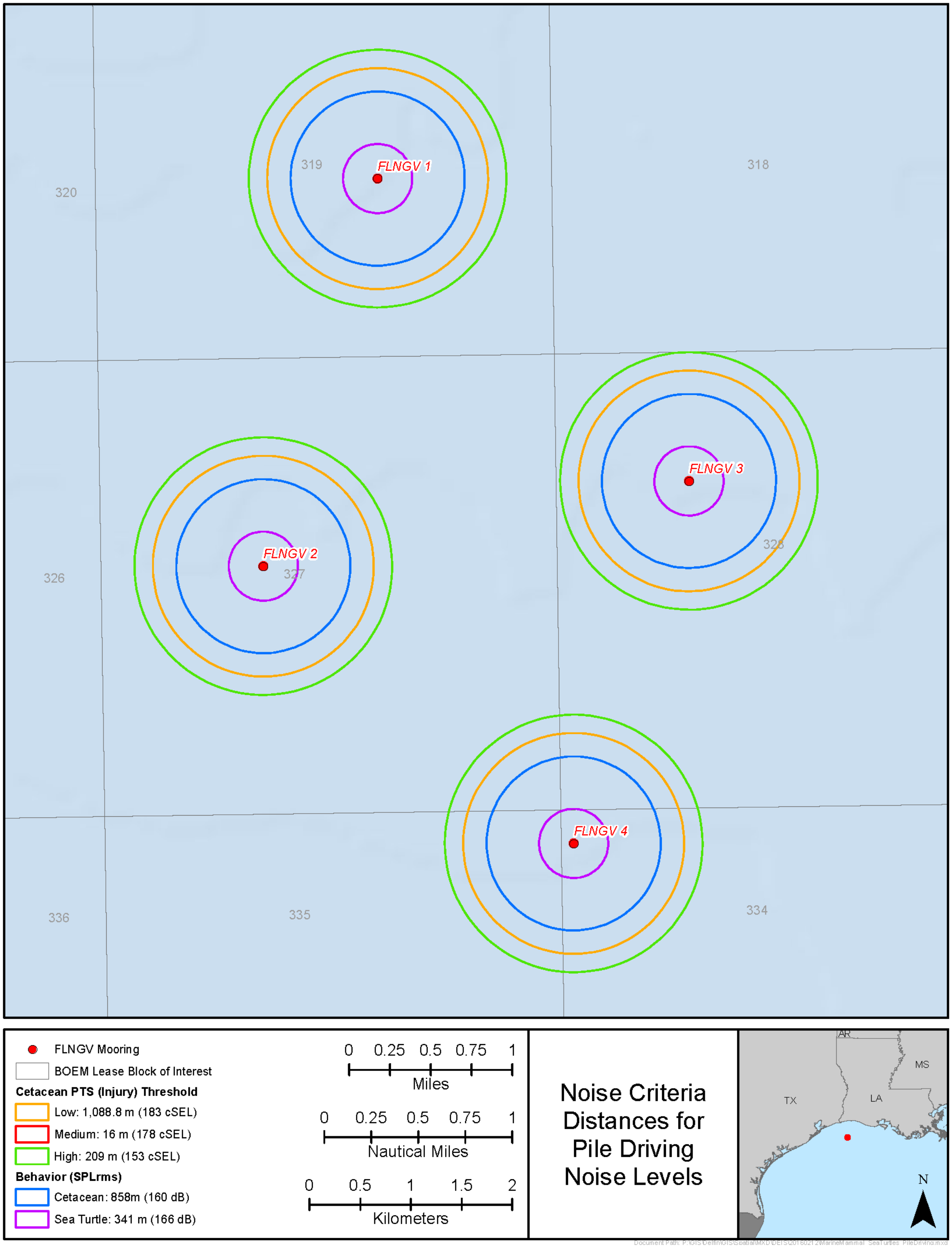


Figure 4.3-1. Noise Criteria Distances for Pile-Driving Noise Levels

The calculated impact threshold radii for a 78-inch steel pile encompassed in the cofferdam are listed in Table 4.3-3 for cetaceans. Weighting functions are not used in calculating the peak sound pressure level (SPL_{pk}) threshold radii. To calculate the cumulative sound exposure level (cSEL) threshold isopleths for cetaceans, NOAA Fisheries (2016b) calculations include accumulation period as well as weighting functions to account for the differences in audible bandwidths amongst cetaceans. NOAA Fisheries (2016b) provides alternative methods for incorporating these parameters into calculations of the cetacean PTS SEL isopleths. Weighting functions can be calculated for a specific source or default weighting factor adjustments (WFAs) can be uniformly applied. Accumulation periods can be incorporated using the root mean square (90%) sound pressure level (SPL_{rms}) source method or the single strike equivalent method. The radii in these analyses were determined by applying NOAA Fisheries' default WFAs and the single strike equivalent alternative. Using default WFAs rather than modeling weighting functions will result in slightly larger (more conservative) isopleths. The SPL_{rms} method produces unrealistically large isopleths because it assumes that animals at the edge of the isopleth will remain there for the entire activity (accumulation) period. Additionally, large cetacean occurrence in the proposed Port location is unlikely, although smaller marine mammals (e.g., dolphins) are possible. No distinct marine mammal foraging habitat has been identified in the vicinity of the proposed Port location. For that reason, the single strike alternative was selected. These topics are highly complex and their full explanations are not within the scope of this document. Please refer to the NOAA Fisheries (2016b) guidance document for a full discussion of the entire 2016 noise criteria component.

Table 4.3-3. Estimated Distances to Cetacean Species Threshold Levels for a Mitigated 78-Inch Pile

Threshold Criteria		Low-Frequency Cetacean Thresholds (meters)	Mid-Frequency Cetacean Thresholds (meters)	High-Frequency Cetacean Thresholds (meters)
Permanent Threshold Shift	SEL (dB re 1 μPa^2•s)	1,088.8	38.7	1,296.9
	SPL_{pk} (dB re 1 μPa)	1.0	0.2	14.0
Temporary Threshold Shift	SEL (dB re 1 μPa^2•s)	10,887.8	387.2	12,969.0
	SPL_{pk} (dB re 1 μPa)	3.0	0.5	34.0
Level B Harassment	$SPL_{rms90\%}$ (dB re 1 μPa)	858		

Key:
SEL = sound exposure level; SPL_{pk} = peak sound pressure level
SPL_{rms90} = root mean square (90%) sound pressure level
dB re 1 μPa = decibels relative to 1 microPascal

Based on Buehler et al. (2015), noise levels from mitigated pile driving can exceed the NOAA Fisheries harassment thresholds for pulsive noise for Level A (PTS) and Level B (160 dB re 1 µPa @ 1 m) criteria. Sperm whales are generally found in waters deeper than 590 ft (180 m) and are known to occur in the northern Gulf of Mexico (MMS 2006). At the closest distance, such depths are approximately 80 miles south of the proposed Port location. NOAA Fisheries recommends 160 dB re 1 µPa @ 3.28 ft (1 m) be used as the onset threshold of behavioral disturbance. Although these distances would possibly be within the zone of audibility for sperm whale located at the 590-ft (180-m) isobaths where it is frequently sighted, it would not likely be within the zones of responsiveness (TTS) or injury (PTS), where noise levels attenuate below these criteria less than 0.25 mile (0.04 km) from the source for mid-frequency cetaceans (see Table 4.3-3). Therefore, adverse impacts from construction noise on ESA-listed marine mammals would be expected to be insignificant. While the potential for take may exist, all recommendations from Federal and State consulting agencies would be followed to avoid and monitor impacts to marine mammals. To prevent Level A take and minimize the potential for Level B take, Delfin LNG would implement mitigations as listed in Section 4.3.10 that include measures such as, but not limited to, use of the lowest noise-producing impact hammer available, use of a cofferdam system (including the introduction of bubbles within the annulus between the pile and the cofferdam to reduce the transmission of marine noise), use of the pile-driving soft start ramp-up procedures preceded by clearing the surrounding waters by a PSO, and call for a suspension of pile driving by the PSO should a protected species be observed in proximity to the active pile driving operation.. With mitigations in place and given the distance to the 590-ft (180-m) isobaths approximately 80 miles south, noise from pile driving may affect but would not likely adversely affect ESA-listed marine mammals in the project area.

Ships would produce short periods of continuous noise via the use of DP thrusters (see Section 4.10.1.2). Although use of thrusters is louder than general shipping transit noise, it still would be less than the noise levels associated with large commercial container ships and tankers at cruising speed. For example, studies (LGL 2006) have used approximately 190 dB as the expected noise level for an LNGC's thrusters. Pipelaying barge thrusters emit approximately 172 dB microPascal root mean square (µPa rms) at 1 m, and tugs emit 170 dB µPa rms (Wyatt 2008). Generally, tug and barge thruster noise attenuates to 144 dB µPa rms within 60 m (Wyatt 2008). However, most of the construction vessels that would be used at the proposed Port and along the proposed WC 167 bypass and pipeline laterals would be positioned by anchors and not have installed thrusters. The modeling of construction noise impacts from vessels were based on the following representative scenario. Construction will require the use of DP vessels for delivery of supplies and construction materials and potentially for positioning of construction vessels as they prepare for anchoring at the construction site. All of the constructions vessels in this scenario (pipelay barge, crane barge, and dive support vessel) are assumed to be already in place and anchored and would not operate in a DP thruster mode within the modeled 24-hour assessment period. The anchored vessels would require servicing from an offshore supply vessel (OSV) for crew changes, maintenance, and delivery of construction materials. The servicing OSV will remain relatively stationary while operating in DP mode as it makes the service calls to each anchored platform. The OSV would not be on site for longer than 3 hours every 24-hour period. Additionally, all DP thruster activity is assumed to occur within a 1 km range over the entire 3-hour period. Because there is only one OSV vessel operating in DP mode in the scenario, the source level for the scenario is 186 dB re 1 µPa SPL_{rms}, which is equal to that of the OSV alone.

The modeling software, dBsea (©Marshall-Day), was used to forecast the underwater acoustic fields resulting from the construction vessels (Table 4.3-4 and Figure 4.3-2). The model makes use of several types of user-defined environmental data, including bathymetry, speed of sound through the water column (sound speed profiles), and geoacoustic properties of the seabed. Frequency dependence of sound propagation characteristics is treated by computing acoustic transmission loss at the center frequencies of 1/3-octave bands.

Table 4.3-4. Estimated Distances to Cetacean Species Threshold Levels for Construction Vessel Activities

Threshold Criteria		Low-Frequency Cetacean Thresholds (meters)	Mid-Frequency Cetacean Thresholds (meters)	High-Frequency Cetacean Thresholds (meters)
Permanent Threshold Shift	SEL (dB re 1 µPa²•s)	66	4	58
Temporary Threshold Shift	SEL (dB re 1 µPa²•s)	1,431	81	1,985
Behavior	RMS 90% (dB re 1 µPa)	21,975		
Key: SEL = sound exposure level; dB re 1 µPa = decibels relative to 1 microPascal				

The behavioral threshold criteria used for cetaceans do not take into consideration frequency weighting or exposure periods, resulting in large ZOIs. Additionally, ambient noise levels can reach SPL_{rms}150 dB re 1 µPa at the project site with average ambient levels (123 dB re 1 µPa) exceeding the 120 dB re 1 µPa SPL_{rms} threshold criteria. Therefore, any impact assessment should take into consideration the ambient conditions.

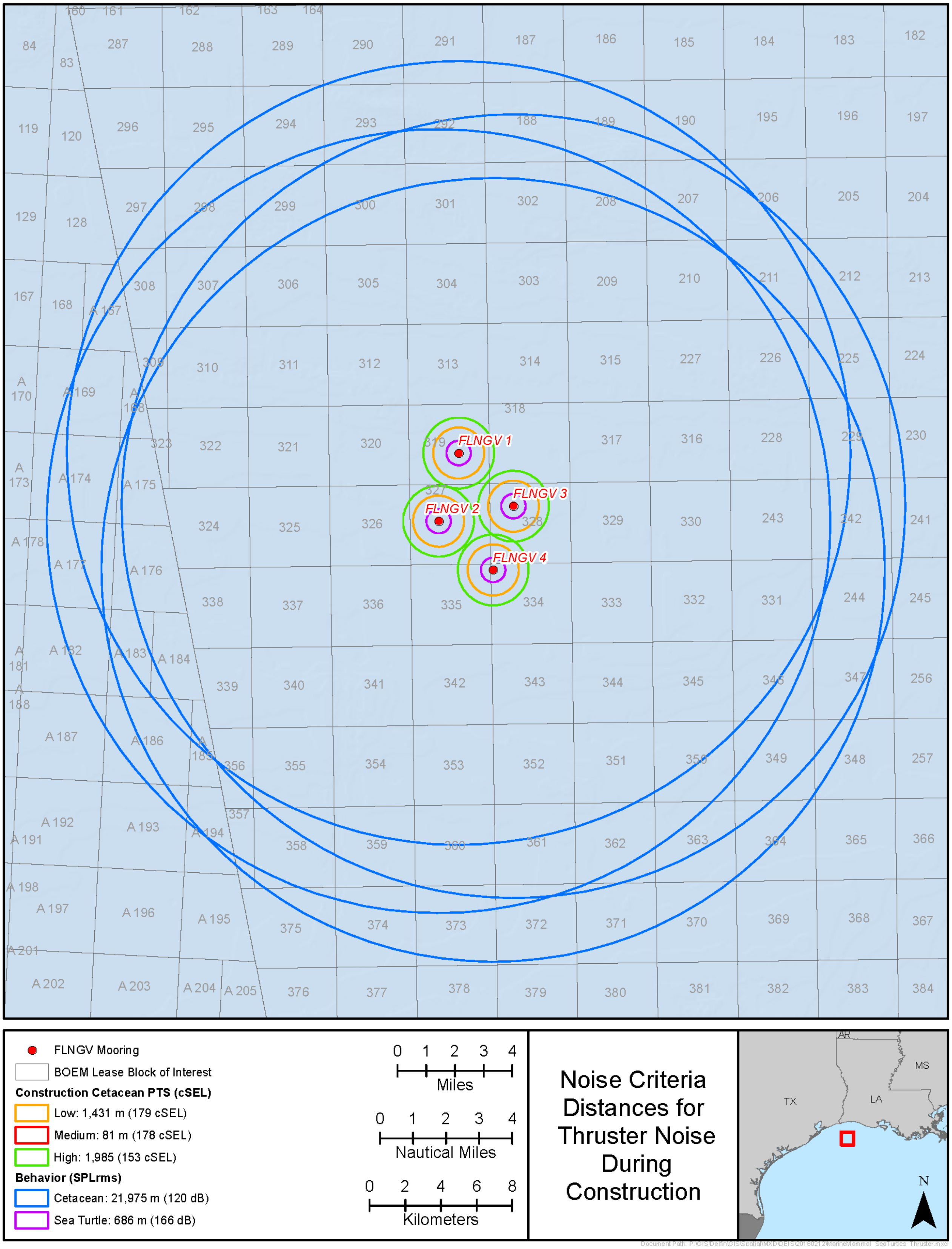


Figure 4.3-2. Noise Criteria Distances for Thruster Noise during Construction

NOAA Fisheries technical guidance identifies the zone of injury as the range of received levels from species-specific Level A PTS thresholds, and TTS and 120 dBL rms Level B harassment from continuous noise for marine mammals. Thruster sound source levels may vary in part due to vessel size, propulsion power, or the activity engaged. Thruster noise is generated by cavitation and has a relatively flat spectrum shape due to the large number of random bursts caused by various sized bubbles collapsing. The discrete spectral "blade rate" component occurs at multiples of the rate at which any irregularity in the flow pattern or in the impeller itself is intercepted by the impeller blades. Thruster broadband linear source values can range from 177 to 189 dB re 1 μPa assuming full engine loads occurring during short-term maneuvering operations under load. Thruster studies in similar conditions found the distance to the harassment marine mammal 180 dB RMS threshold negligible and distances to the 160 dB RMS harassment threshold would be 20 m or less from a DP vessel with thrusters operating at full power (Samsung 2009; Hartin et al. 2011).

Potential effects of exposure to continuous sound on marine mammals include non-injury harassment (TTS), or physical damage to the ear region or other physical harm (PTS). It may also cause physiological stress responses, and behavioral responses such as startle response, alarm response, avoidance, and possibly, lack of response due to masking of acoustic cues. Continuous noise created by construction vessels could create masking effects among marine mammals. Ambient noise levels in the Action Area are currently elevated though variable due to existing levels of shipping, fishing, and recreational vessel traffic. Construction vessel traffic for the proposed Project would result in temporary increases in noise. While an increase, it would have a minimal contribution to the existing ambient noise. In general, marine mammal exposure to construction vessel noise would only occur for a finite time and would not be expected to have long-term population-level impacts on marine mammals. Given the shallow habitat of the proposed Project footprint (approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 ft [19.5 to 21.9 m] where the shelf break and known ESA-listed species water depths in this area lie roughly 80 to 100 miles [128 to 160 km] offshore), large whales, particularly sperm whales, would not likely be within the zones of responsiveness (TTS or PTS). Therefore, adverse impacts from such construction noise on ESA-listed marine mammals would be expected to be insignificant.

Helicopter trips are expected during construction. Rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al. 2003) though generally, noise levels from helicopters do not pose a direct impact on the hearing of marine mammals (Richardson et al. 1995). In addition, helicopters would likely not pass over deeper waters (deeper than 590 ft [180 m]) where ESA-listed whales are likely to occur, which are located approximately 80 miles south of the proposed Port location. It is expected that helicopters would follow the voluntary practices of the FAA's Advisory Circular No. 91-36D, which requires that an altitude of 2,000 ft (610 m) over NSAs be maintained.

The behavioral response of marine mammals to a perceived marine sound depends on a range of factors, including: (1) the SPL; (2) frequency, duration, and novelty of the sound; (3) the physical and behavioral state of the animal at the time of perception; and (4) the ambient acoustic features of the environment (Hildebrand 2005). Because of this, it is more difficult to predict behavioral shifts due to anthropogenic sounds. The radiation of sound to marine waters during the construction phase of the proposed Project would be within the immediate vicinity of the proposed Project, and effects are expected to be temporary, hence "harassment" from noise (TTS) for all species is expected to be minor. Although species abundance varies by season in the Action Area waters, the likelihood of "harm" (PTS) or "harassment" (TTS) from the proposed Project to individuals or species due to underwater sound is unlikely because of the transient and seasonal nature of the species moving through the Action Area waters, and the ability of animals to move away from sound sources.

Noise effects from activities other than thrusters, including from helicopters, on marine mammals may range from minor to moderate, would be direct, adverse, and short-term within the immediate vicinity of the proposed Port. However, impacts from continuous noise from construction activities are expected to be insignificant on ESA-listed marine mammals in the Action Area as they would be short-term, intermittent, and the marine mammals known to occur are highly mobile can avoid sources of noise. While construction noise is continuous when occurring, it is transient and short-term.

No ESA marine mammal species are expected closer than approximately 80 miles to the south of the proposed Project; therefore, no effects on ESA-listed marine mammal species are expected in the proposed Port location. While continuous noise outputs are short in duration, were a marine mammal to occur in the vicinity, effects of thrusters could exceed the acoustic thresholds established for these animals. Thruster noise outputs may result in a Level A take under the MMPA on the marine mammal species in the proposed Port location since levels would exceed NOAA's guidance levels for acoustic take. However, mitigations, as described in Section 4.3.10 will be followed during all construction activities and ESA-listed marine mammals are not expected within approximately 80 miles of the proposed Port location. As detailed in Section 4.3.10, the Applicant has committed to the minimal safe operating power for DP thruster vessels to be maintained at all times and thrusters will not be engaged unless required. Thruster power will also be reduced to the absolute lowest safe operating levels if marine mammals or sea turtles are detected within 500 m of DP vessels, and other vessels in the immediate vicinity would be instructed to reduce to slow speed and minimum safe operating power consistent with the activities being performed. Therefore, thruster noise would have a mitigatable and insignificant impact on marine mammals. Continuous underwater construction noise impacts may affect, but are not likely to adversely affect ESA-listed marine mammals.

Vessel Traffic

The increased vessel traffic that would result from the proposed Project would increase the risk of ship strikes in both the proposed Port location and EEZ waters (throughout the Action Area). Mammal species potentially occurring in the ROI would be susceptible to vessel strike during construction of the proposed Project. Impacts from vessel collisions take two forms, propeller wounds and blunt trauma, and can cause injury or mortality to the individual involved (Laist et al. 2001). If struck, serious injury or mortality to the animal would result. Sub-lethal injury would range from minor to serious impacts, potentially leading to decreased feeding and reproductive success. Vessel strikes, especially with threatened and endangered marine species world-wide, represent a direct, major, adverse impact resulting in physical injury or death. While it is known that an increase in vessel traffic increases the risk of collision, the proportional probability of that risk associated with construction vessels cannot be quantified, particularly when vessel traffic is already high.

The Large Whale Vessel Strike Database (Strike Database) has documented 292 incidents of large whale/vessel collisions from 1975 to 2002, involving 11 species of whales. Of those incidents, 48 resulted in injury and 198 were fatal. The vessels involved in collisions included recreational vessels, freighters, tankers, cruise ships, and Navy vessels, among others (Jensen and Silber 2004). The majority of serious injuries and mortalities are a result of impact with large vessels (greater than 262 ft long), although smaller vessels have caused some of these impacts (Laist et al. 2001). Small vessels might cause fewer collisions because they generally operate in clear weather and are relatively maneuverable, whereas larger vessels are less likely to detect nearby whales to be able to avoid collisions (Laist et al. 2001).

Where vessel speed was known (58 incidents), the Strike Database reported speeds ranging from 2 to 51 knots; most collisions occurred when vessels were traveling at speeds of 13 to 15 knots (Jensen and Silber 2004). A more recent study, which evaluated the effects of impact speed on whales, determined that a vessel traveling at 10.5 knots had a 50 percent chance of causing serious injury or mortality to the affected individual. This probability increased to 75 percent for vessels traveling at 14 knots, and exceeded 90 percent for vessels traveling at 17 knots (Pace and Silber 2005).

The Strike Database documented eight confirmed vessel strikes of large whales in the Gulf of Mexico, including two right whales, one humpback whales, two sperm whales, one finback whale, one minke whale, and one unknown species. Only one of the strikes, involving a humpback whale, did not result in mortality of the individual. It is likely that the numbers reported in the Strike Database are underestimates of the number of whales struck because it is unlikely that every incident was noticed and reported (Jensen and Silber 2004).

When the number of vessel roundtrips associated with Project construction is compared with the annual flux of traffic to Galveston Bay, Sabine Pass, and Calcasieu Pass the construction activity would cause a relative minor increase in vessel traffic. These safety fairways serve the Ports of Galveston, Port Arthur, Beaumont, Orange, and Lake Charles. The total number of receipts/shipments for commercial vessels entering and leaving the above ports in 2013 was approximately 122,610 trips for self-propelled vessels and barges (Table 4.3-5). Most of these vessels are large enough to cause injury or death to marine mammals in the event of a strike. An undetermined number of small passenger vessels, sightseeing, and charter fishing boats with less than 18 ft (5 m) of draft account for a significant amount of additional traffic for the region spanned by the above ports. Although certainly possible, these smaller vessels are not as likely to result in mortality in the event of a marine mammal strike.

Table 4.3-5. Commercial Vessel Traffic Entering Nearby Ports in 2013

Location/Port	Cargo Vessel Trips (Includes Self-Propelled Vessels and Barges)
Port Arthur, Orange, and Beaumont, TX	1,443
Port of Galveston, TX	57,766
Lake Charles, LA	63,401
Total	**122,610**
Source: USACE (2016)	

Installation of the offshore components would begin in early 2018 and would take approximately 54 months to complete. Construction and installation of the proposed Project would be completed mid-2022. It is estimated that the majority of vessel traffic would be within the proposed Port location, with large vessel movement and speed contingent upon the task performed and duration (e.g., proposed TYMS installation). These vessels would most likely mobilize and demobilize once per TYMS site. Crew boats, on the other hand, would operate and transit the site more frequently, depending on duty.

Large vessels are only likely to mobilize/demobilize to each TYMS construction site once, whereas smaller vessels may transit the proposed Port location multiple times. Therefore, large vessels used for construction would only be a concern for a short duration. When compared to annual cargo vessel trips for Texas and Louisiana in 2014 (Table 4.3-6), the number of large vessels associated with construction, as detailed in Table 4.3-4, only represents a less than one percent increase in vessel traffic. It is expected that any increase in the potential for vessel strike associated with construction vessels would be proportional to this minimal increase in vessel traffic. Additionally, Delfin LNG has committed to instituting the procedures described in NOAA Fisheries SERO's (2008) guidelines for vessel strike avoidance measures and reporting for mariners. These procedures call for vessels to maintain a vigilant watch for marine mammals and sea turtles to avoid striking sighted protected species.

Table 4.3-6. Construction Vessel Transit Information

Vessel Type	Typical Operation and Duration	Estimated Number of Transits
Derrick Barge	24/7 16 months	4
Material Barge	24/7 20 months	4
Quarters Barge	24/7 20 months	4
Work Boat	24/7 36 months	77
Crew Boat	Every 14 days 36 months	77
Tug Boat	24/7 20 months	40
Pipelay Barge	24/7 TBD	4

If a ship strike were to occur, it would be an immediate adverse effect and significant impact. Reporting procedures related to injured or dead protected species are also included in the NOAA Fisheries guidelines. However, in the event of a ship strike to a marine mammal, the only species that would be vulnerable to a population level impact would be the right whale. As previously mentioned, right whales are considered unlikely visitors to both the proposed Project area and the EEZ associated with LNGC transits. Considering the minor increase in overall vessel traffic, short duration of actual vessel transit, and adherence to NOAA Fisheries SERO (2008) guidelines for vessel strike avoidance measures and reporting, the potential for ship strike on ESA-listed marine mammals would be insignificant. Therefore, the impacts, as described for vessel strike, may affect but are not likely to adversely affect ESA-listed marine mammals.

Ingestion of Marine Debris

Ingestion of oil and dispersants directly or through feeding on contaminated prey which have eaten dispersants, can lead to short or longer-term effects from inflammation, ulcers, bleeding, and possible damage to liver, kidney, and brain tissues in marine mammals. Short-term, negligible to minor, adverse impacts on ESA-listed marine mammals could occur if marine debris were inadvertently released. All construction operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent inadvertent release of debris, making such impacts on ESA-listed marine mammals insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, the ingestion of marine debris may affect but is not likely to adversely affect ESA-listed marine mammals in the proposed offshore Project footprint.

Entanglement

The likelihood of a marine mammal encountering and becoming entangled depends on several factors. The amount of time that lines of any kind are in the same vicinity as a marine mammal can increase the likelihood of it posing an entanglement risk. In addition, any line or cable placement within the water column is a factor. However, entanglement of marine mammals from the proposed Port activities are unlikely because anchor lines securing the derrick/lay barge would be large in diameter, knotless, non-floating, and taut, and would only be deployed for a short period of time, and are thus unlikely to entangle marine species. The likelihood of an ESA-listed marine mammal encountering and becoming entangled with lines in the water column during construction activities is extremely low, and thus discountable. All construction operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials including items that could cause entanglement. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent sources of entanglement, making such impacts on ESA-listed marine mammals insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, the impacts, as described for entanglement, may affect but are not likely to adversely affect ESA-listed marine mammals.

Lighting

Lighting is not expected to cause impacts on ESA-listed marine mammal species. Lights are not a known attractant to marine mammals nor an avoidance trigger. Therefore, potential impacts from lighting would have no effect on ESA-listed marine mammals.

Alteration to Prey Species Abundance and Distribution

Alteration to prey species other than what was address above, is not expected to cause impacts on ESA-listed marine mammal species. Therefore, potential impacts from alteration to prey species would have no effect on ESA-listed marine mammals.

Air Emissions

No impacts are expected to non-listed marine mammals from air emission affects. Therefore, potential impacts from air emissions would have no effect on ESA-listed marine mammals.

Impacts of Operation

Proposed Port operational activities are described in Section 2.2.10. Most proposed Project-related operational activities and their associated impacts, including disturbance of benthic habitat, turbidity, ballast intakes, routine discharges, and maintenance and repair, would be local to the proposed Port location, and thus be out of range of ESA-listed marine mammals. Operational vessel traffic would transit would include LNGC approach routes and the transit and traffic associated with LNGC movements within the proposed Port. Vessel noise from thruster use at the proposed Port site could ensonify areas outside of the proposed Port location where ESA-listed marine mammals could occur; thus, potential effects from construction noise are evaluated.

Benthic Habitat

No impacts are expected to ESA-listed marine mammals from benthic habitat affects. Therefore, potential impacts on benthic habitat would have no effect on ESA-listed marine mammals.

Turbidity

Marine mammals are mobile, and areas of turbidity are expected to be small relative to the area covered by marine mammals on a daily basis. Effects on ESA-listed marine mammals, if any, would take the form of either avoidance of or direct exposure to a small area of turbidity. Avoidance would be quick, would likely not be discernible from the individual's regular travel pattern, and would not be expected to result in a measurable displacement. Given that turbidity occurs naturally in the Gulf of Mexico due to wind and weather events, brief exposure to patches of turbidity would not be expected to adversely affect non-listed marine mammals. Because of this, adverse effects on ESA-listed marine mammals from turbidity are expected to be both short-term and long-term, negligible, and insignificant. Therefore, potential impacts from turbidity may affect but are not likely to adversely affect ESA-listed marine mammals.

FLNGV Ballast Water Discharge

No impacts are expected to ESA-listed marine mammals from ballast water discharge. As stated in Section 4.2.2.2, all vessels would be required to meet CFR Title 46, Chapter I, Subchapter Q, Part 162 that addresses requirements for BWMS to be installed onboard vessels for the purpose of complying with the ballast water discharge standard of 33 CFR Part 151, Subparts C and D. Additional treatment via a copper aluminum anode system would also occur. Routine discharges would be expected to have long-term, minor, direct, and adverse impacts on water quality. However, discharges would be expected to dilute rapidly and marine mammals are highly mobile. Even if they were collocated with the discharges, which is anticipated to be unlikely, they would have no measurable impacts. Therefore, potential impacts from FLNGV ballast water discharge would have no effect on ESA-listed marine mammals.

Routine Discharges

Impacts on ESA-listed marine mammals from routine discharges incidental to the normal operation of a vessel (routine discharges) would be short-term, minor, direct and adverse; however, impacts would be limited to residual nearfield zone effects. Marine mammals would be impacted from the minor degradation of habitat (via water quality pollution) as a result of discharges of water from construction vessels (e.g., deck drain runoff, engine cooling water, bilge water, or treated sanitary wastewater). These discharges would be of limited in duration and would be similar to those from other boats and barges in the area. Routine discharges would be localized and, thus, would not be expected to impact ESA-listed marine mammals considering these species are not generally expected within approximately 80 miles of the proposed Port location. Warmed seawater discharges would consist of small, localized, warm water plumes that would be expected to return to ambient temperatures not far from the discharge point. Discharged treated domestic sanitary wastewater from vessels would be expected to be diluted within the open ocean, and thus have short-term, minor, adverse effect. However, such routine discharges would impact ESA-listed mammals only near discharge points, which is insignificant and discountable. Similarly, cooled seawater discharges would consist of a small, localized coldwater plume and may have the potential to impact ESA-listed marine mammals if they were collocated with the discharge and in the nearfield zone, the likelihood of which is insignificant and discountable. Hydrostatic test water discharges are subject to NPDES permit requirements and application of USEPA’s ocean discharge criteria (in Federal waters) or to water quality standards for discharges into State waters. Given the relatively low volume of the discharge and the high dilution rate (within 100 m), and that the warmed seawater discharges from engine cooling would consist of a small, localized, warm water plume, routine discharges that would be expected to have only minor impacts near discharge points. Short-term and long-term, discountable, and insignificant impacts on ESA-listed mammals from brine reject water, treated domestic sanitary wastewater from the support platform and offshore service vessels, chlorinated seawater used to test the firewater system, industrial wastewater from equipment washdown, and treated hypochlorite generator wastewater would be expected. These discharges would be permitted through the Applicant’s NPDES permit and would not exceed current effluent discharge standards.

No adverse impacts on water quality would be expected during operation of the pipelines. Operation of the pipelines would consist only of the transmission of natural gas. Therefore, it is not anticipated that contaminants would be released to the water column or sediment during operation of the pipelines. Should a leak or break occur in the pipeline or flowline, safety devices would shut down gas flow and isolate the pipeline. The natural gas would bubble to the surface and disperse.

Routine discharges would include deck runoff and engine cooling water. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from FLNGVs, LNGCs, and support vessels would comply with USCG requirements and the requirements highlighted in Table 1.5-1. The use of well-maintained vessels designed and operated in compliance with the applicable regulatory requirements is expected to ensure that routine discharges from marine vessels would result in insignificant and discountable impacts on water quality, especially given the limited time frame LNGCs and support vessel would be in the area. As a result, overall impacts from routine operational discharges, which would be of limited duration and which are similar to those from other commercial container and tanker vessels currently operating in the area, may affect but are not likely to adversely affect ESA-listed marine mammals.

Accidental Releases of Fuel, Oil, and Other Chemicals

Impacts from the accidental release of fuel, oil and other chemicals have the potential to be severe in intensity due to the unpredictable nature of such discharges and lack of control over volume and extent of the spills, and lack of control over the time they may last. Cumulative effects can occur, especially in the Gulf of Mexico where the Deepwater Horizon oil spill, as an example, has already changed the baseline environment for marine mammals. However, the site of this event is over 300 miles to the east of the propose Project. The proposed Project would increase tanker traffic in and around the Gulf of Mexico, increasing the potential for ship collisions and other accidents that could result in hazardous material spills from tankers (either from LNG cargo or fuel supplies or cargo from non-LNG vessels). Any such spills, should they occur, could have a negative impact on the environment of the region.

Because marine mammals require routine contact with the sea surface, these species experience high risk from impacts of floating oil sheens. Oil and gas spills can have a direct impact on marine mammals from inhalation of toxic fumes, which can lead to brain lesions, stress, and disorientation. Studies have shown that oil from spills not only causes acute short-term mortality, but that tanker accidents and the resulting spilled oil can persist in the marine environment for more than a decade, resulting in long-term impacts at a population level.

In addition to the direct effects of oil and dispersants, cleanup and containment operations also may have an effect on marine mammals. Cleanup includes containing oil in booms, skimming oil at the ocean surface, and burning. Cleanup also involves a large number of vessels and aircraft in the coastal and offshore habitats bringing increased noise levels and human presence into marine mammal habitats. These activities could stress and disturb marine mammals, potentially displacing them from important feeding or breeding grounds and disrupting normal behavior.

If a spill were to occur in the proposed project area, adverse impacts on marine mammals would range from minor to major, depending upon the size of the spill; however, such events would be unlikely and discountable, particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. Therefore, accidental spills may affect but are not likely to adversely affect ESA-listed marine mammals in the proposed Port footprint.

As discussed in Section 4.2.2.2, Delfin LNG would prepare an FRP that addresses the potential for petroleum-based spills and describes preventive and response measures that would be implemented in the event of a spill. While the occurrence of ESA-listed marine mammals is not expected within 80 miles of the proposed Port, with the FRP, immediate response actions could further reduce potential impacts, if they occur, on ESA-listed marine mammal populations.

LNG Spills

Short-term, minor, direct, adverse impacts on marine mammals could occur in the unlikely event of an LNG spill; however, such events would be unlikely and discountable particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. All FLNGVs are designed with features to minimize the potential for LNG spills. However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in frostbite or death and asphyxiation by natural gas vapors above the surface of the water. These impacts would likely occur in the immediate vicinity of the spill location; the time frame of the impact is limited. Since LNG would boil off as natural gas at the surface, depth and pressure required for gas to dissolve in surface waters would not be sufficient and gas vapors would disperse. In addition, the time frame for these impacts would be limited, and adverse toxic impacts would be expected to be minor after the LNG boiled off and the vapors dispersed.

The potential for a release of natural gas from the existing UTOS/HIOS pipeline system and proposed WC 167 bypass and pipeline laterals is remote and discountable. If there were a subsea release of natural gas, the gas would rise to the water surface rapidly and dissipate. In general, whether a release is sudden or extended, physics dictate that any methane would only minimally and insignificantly dissolve into the water column during the lifetime of the bubble as described by Fick's law, taking into account Henry's law of constants, partial pressure, and concentrations of dissolved gases. Once a gas bubble reaches the surface, it would rise (being lighter than air) and be dispersed by air currents. Marine mammal impacts from such a release would be short-term, minor and discountable. Impacts from potential release of natural gas may affect but are not likely to adversely affect ESA-listed marine mammals.

Planned and Unplanned Maintenance and Repair

Beyond impacts associated with vessel transits, including intake and discharge of water, and the risk of vessel strike, no adverse impacts on ESA-listed marine mammals are expected to occur during planned and unplanned maintenance and repair. During the operational period, maintenance of the pipeline would include pigging to periodically clean out residual materials. The release of these materials into the surrounding environment can lead to water quality impacts and contamination of adjacent benthic habitats. However, due to the expected short duration of these impacts, if they occur, no significant negative effects on marine populations within the proposed Project area are expected. It is anticipated that such internal inspections would be conducted approximately once every 7 years and impacts would be discountable. Therefore, the impacts from maintenance and repair may affect but are not likely to adversely affect ESA-listed marine mammals.

Noise

The radiation of sound to marine waters during operations is expected to be temporary, hence "harassment" (TTS) for all species would be considered minor. Although species abundance varies by season and species in Action Area waters, the likelihood of "harm" (PTS) or "harassment" (TTS) from the proposed Project to individuals or species due to underwater sound would be unlikely because of the transient and seasonal nature of the species moving through Action Area waters and the ability of animals to move away from sound sources.

Long-term, minor, adverse impacts on marine mammals would result from continuous noise produced during operation of the proposed Port (see Section 4.10.2). The noise level in the water is expected to be 109 dB during operation and the use of LNGCs represents an additional noise source. Broadband noise estimates for LNGCs traveling at full speed (20 knots) and half speed (8 to 10 knots) would be 192 dB and 175 dB in water, respectively (USCG and MARAD 2008). Broadband noise generated by offshore service vessels traveling at full speed (12 to 16 knots) and half speed (6 to 8 knots) is estimated at 186 and 183 dB, respectively. Depending on the season and receiver depth, the 120 dB contour of LNGCs and offshore service vessels traveling at either full speed or half speed would extend 1.5 to 1.7 miles (2.4 to 2.7 km), encompassing an area between 6.9 and 9.7 miles (17.8 and 25.1 km^2). Marine mammals close to the transit route could be exposed to noise exceeding 120 dB for approximately 20 to 25 minutes The 180 dB contour of LNGCs and offshore service vessels traveling at either full speed or half speed would extend no more than 6.56 ft (2 m) from the vessel, and therefore is not considered an issue. It is possible that dolphins can bow ride the vessel and they would therefore be within this distance.

Regarding noises generated at the proposed Port, the FLNGVs would be used for natural gas liquefaction and storage. The natural gas would be further treated, super-cooled, and liquefied on the FLNGVs, and stored onboard each FLNGV until delivered to LNGCs via ship-to-ship transfer through loading arms or cryogenic hoses. The LNGCs would be maneuvered alongside, under the control of a Mooring Master and with tug assistance, and would moor next to the FLNGVs (side-by-side arrangement). This continuous noise output is expected to be for short periods. During routine Port operations, transient noise would be generated by LNGCs and support vessels.

During operation, thrusters would generate noise that exceeds the Level A and Level B harassment threshold for continuous noise (120 dB re 1 µPa). However, there are no listed species expected in the shallow Project waters where the thruster noise would be generated. Therefore, although sperm whales, for example, at the 590-ft (180-m) isobath (approximately 80 miles to the south) may be within the zone of audibility for noise from thrusters, they would not be expected within the zones of responsiveness or injury, as defined by the Levels B and A thresholds, respectively. Adverse impacts on ESA-listed marine mammals from operational noise are therefore expected to be minor and insignificant.

Noise modeling as described in Section 4.3.1.1 was undertaken to assess operational noise based on the following representative scenario. An empty LNG carrier would berth at the FLNGV (liquefaction vessel), escorted into the proposed Delfin LNG facility area by tugs. Four tugs are attached and provide assistance within approximately 1 km of the FLNGV mooring. The tugs would be connected by line to the LNGC and use their engines/thrusters to control and arrest the LNGC as it positions alongside the FLNGV. The FLNGV is moored to a tower yoke mooring system (moored by the bow in a weather vanning arrangement) but can use any of its three installed propulsion thrusters to position the FLNGV in relation to the wind/waves. The propulsion thruster on the FLNGV is an azimuthing directional thruster (one of three propulsion thrusters). During normal operations, the propulsion thrusters are engaged only when the FLNGV is receiving an LNGC. For this scenario, we assumed that when an LNGC is arriving or departing, there will be four tugs with thrusters operating at very slow speed (1 to 2 knots) and the FLNGV is using one of its thrusters for positioning to receive or release the LNGC with tugs attached. While the tugs are moving very slowly during mooring (3 hours) and departure (1 hour), they could be using their thrusters under significant power to arrest the incoming ship or move the FLNGV into position (or away from the FLNGV during un-mooring). The scenario assumes that while there are a total of four moorings proposed for the facility, only one mooring operation will be conducted within a single 24-hour period. The tugs are used for 3 hours within the vicinity of the mooring during arrival and 1 hour during departure. Thus, the combination of tug thrusters and FLNGV thrusters (for positioning) is only expected to last for a maximum of 4 hours to complete a cycle within any single 24-hour period. During this time, the LNGC is expected to be at or near idle and would not contribute appreciably to the source levels. All DP thruster activity is assumed to occur within a 1-km range over the entire 4-hour period. The activity of the four tugs plus the FLNGV positioning produces a combined SPL_{rms} source level of 193 dB re 1 µPa. Results from the noise modeling are presented in Figure 4-3.3 and Table 4.3-7.

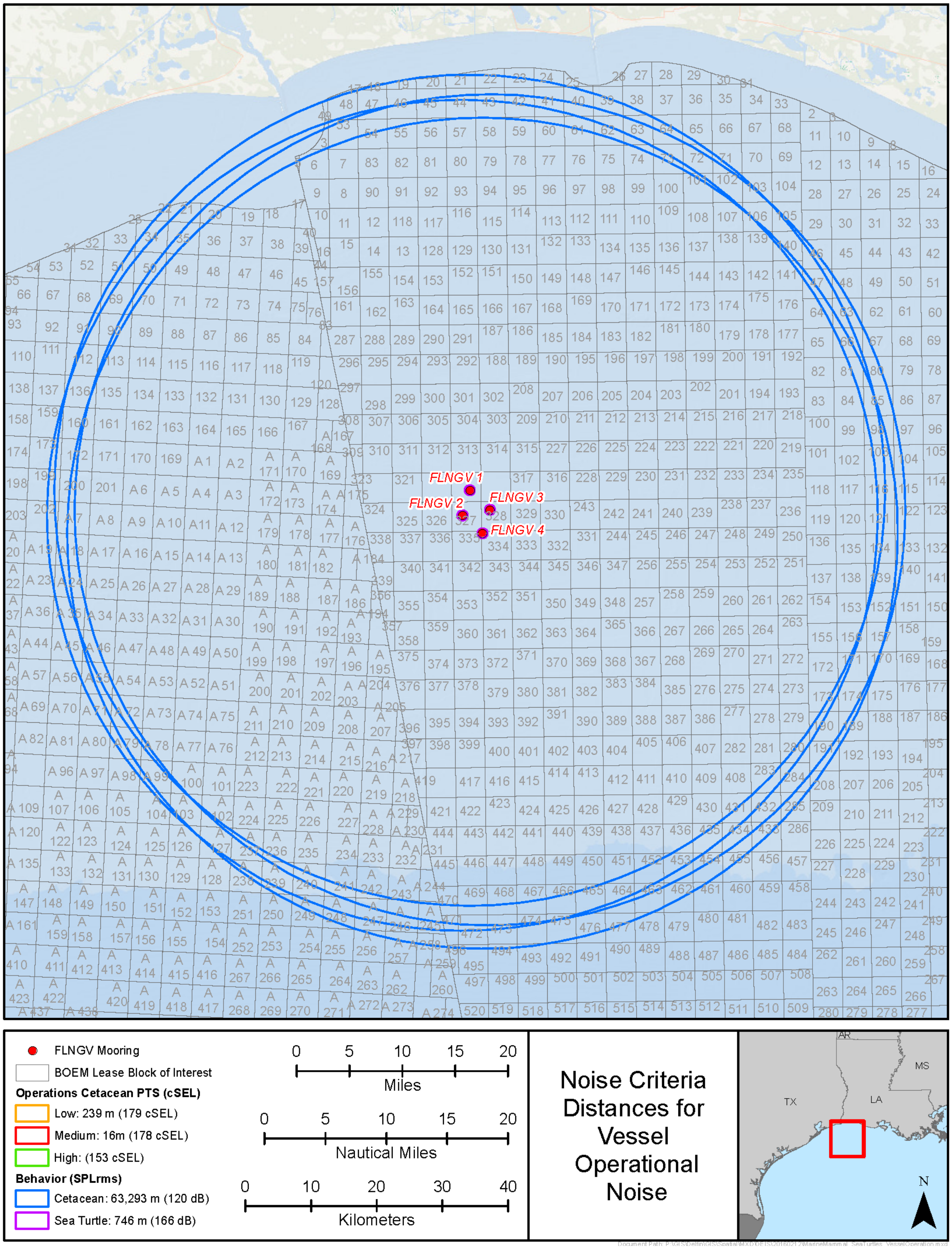


Figure 4.3-3. Noise Criteria Distances for Vessel Operational Noise

Table 4.3-7. Estimated Distances to Cetacean Species Threshold Levels for Operational Vessel Activities

Threshold Criteria		Radial Threshold Distance in meters for the Propagated Acoustic Energy		
		Low-Frequency Cetacean Thresholds	Mid-Frequency Cetacean Thresholds	High-Frequency Cetacean Thresholds
Permanent Threshold Shift	SEL (dB re 1 μPa²•s)	239	16	209
Temporary Threshold Shift	SEL (dB re 1 μPa²•s)	5,055	290	7,149
Behavior	RMS90% (dB re 1 μPa)	63,293		

Key:
SEL = cumulative sound exposure level
RMS90%= root mean square (90%)
dB re 1 μPa = decibels relative to 1 microPascal

Helicopters used during operation would likely not pass over deeper waters where whales are likely to occur, as helicopters would likely be transiting from onshore to the proposed Port for support and supplies and not approach the 590-ft (180-m) isobath located approximately 80 miles to the south of the proposed Port location. As described under construction noise, rotary-wing aircraft (helicopters) produce low-frequency sound and vibration (Pepper et al. 2003) and generally, noise levels from helicopters do not pose a direct impact on the hearing of marine mammals (Richardson et al. 1995). In addition, it is expected that helicopters would follow the voluntary practices of the FAA's Advisory Circular No. 91-36D, which requires that an altitude of 2,000 ft (610 m) over NSAs be maintained.

During routine Port operations, transient noise would be generated by LNGCs and support vessels. With the use of LNGCs, effects from operation noise are expected to be long-term, moderate, direct, with the potential for adverse effects on marine mammals along the transit route for LNGCs. With no mitigation, operation noise outputs have the potential to result in a Level A take under the MMPA on species in the Action Area if they were within the zone of acoustic influence since levels would exceed NOAA's guidance levels for acoustic take. Likewise, they would also have the potential to exceed the levels established for marine mammals as described in Section 3.10.4.2 for Level B take. However, given the shallow habitat of the proposed Project footprint (approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 ft (19.5 to 21.9 m) where the shelf break in this area lies roughly 80 to 100 miles (128 to 160 km) offshore, ESA-listed whales would not likely be within the zones of responsiveness (TTS or PTS). Therefore, adverse impacts from operational noise on ESA-listed marine mammals would be expected to be insignificant. While the potential for take may exist, all recommendations from Federal and State consulting agencies would be followed to avoid and monitor impacts to ESA-listed marine mammals. As detailed in Section 4.3.10, the Applicant has committed to the minimal safe operating power for FLNGVs to be maintained at all times and DP thrusters would not be engaged unless required. Thruster power would also be reduced to the absolute lowest safe operating levels if marine mammals or sea turtles are detected within 500 m of an FLNGV, and other vessels in the immediate vicinity would be instructed to reduce to slow speed and minimum safe operating power consistent with the operations being performed. To prevent Level A take and minimize the potential for Level B take, Delfin LNG would implement the standard mitigations for marine mammal monitoring during operations, as stated in Section 4.3.10. With mitigations in place, operation noise impacts may affect, but are not likely to adversely affect marine mammals.

Impacts from operation noise activities are expected to be mitigatable on marine mammals in the proposed Project area. The marine mammals known to occur can avoid the noise because they are highly mobile. In addition, the amount of noise created by vessel operations would be negligible when compared to ambient noise levels in the ROI. Based on the proximity of the proposed Project area to important shipping centers like Sabine-Neches Ship Channel and the Port of Lake Charles, and the proximity to the Sabine Pass Safety Fairway (Figure 1-1), it can be expected that the background noise is dominated by large vessels (i.e., tankers, container ships) that produce source levels of 180 to 190 dB re 1 µPa RMS at frequencies between 200 and 500 hertz (Hz) (Jasney et al. 2005). If background noise levels in the vicinity of the proposed Project exceed those of the NOAA Fisheries thresholds, then marine mammals would not be affected by any sound less than the existing dominant noise levels. It can be assumed that vessel noise associated with the proposed Project would not add greatly to the existing background vessel noise in the region. Furthermore, noise from operational activities would be short-term in duration and moderate in intensity. Therefore, long-term, major, adverse impacts on ESA-listed marine mammals would not be expected.

Vessel Traffic

As stated for vessel traffic for construction impacts above, impacts from ship strikes are possible as a result of the LNGC use of the approach routes and the transit and traffic associated with LNGC movements. Impacts from vessel traffic associated with operation activities would result in short-term, minor, adverse impacts on ESA-listed marine mammals.

Long-term, minor, adverse impacts on ESA-listed marine mammals would result from increased vessel traffic during operation. In general, an increase in vessel traffic would increase the likelihood of a collision. A vessel strike of a marine mammal would be an adverse, direct impact. The smaller non-ESA listed marine mammals (dolphins) may ride the bow waves of nearby vessels and seem adept at avoiding injury. Impacts would be similar to those described under construction. Considering the minor increase in overall vessel traffic, and adherence to NOAA Fisheries SERO's (2008) guidelines for vessel strike avoidance measures and reporting, the potential for ship strike on ESA-listed marine mammals would be insignificant and discountable. Therefore, the impacts, as described for vessel strike, may affect but are not likely to adversely affect ESA-listed marine mammals.

Vessel strikes could occur as a result of support vessel traffic during proposed Project construction and would impact ESA-listed marine mammals in the same manner as for non-endangered marine species. Each of the Federally listed marine mammal species potentially occurring in the ROI would be susceptible to vessel strike during construction of the proposed Project, as there are recorded incidents of each of these species being involved in a vessel collision. Impacts from vessel collisions take two forms, propeller wounds and blunt trauma, and can cause injury or mortality to the individual involved. Sub-lethal injury could range from minor to serious impacts, potentially leading to decreased feeding and reproductive success. If struck, serious injury or mortality to the animal would result. Any marine mammal strike would be considered a "take" under the MMPA. If a threatened or endangered marine mammal were to be struck, it would also be considered a "take" under the ESA and the MMPA and would require issuance of an incidental take authorization under Section 101(a)(5) of the MMPA. While it is known that an increase in vessel traffic increases the risk of collision, the proposed Port would contribute a relatively small percentage increase in the overall vessel traffic density in the region. Although the probability of threat risk of a vessel cannot be specifically quantified, the vessel management precautions which the Applicant has agreed to employ make the risk of a ship strike negligible (see Section 4.3.10).

Ingestion of Marine Debris

Long-term, negligible to minor, adverse impacts on non-ESA listed marine mammals could occur due to marine debris associated with operation. As previously noted, marine mammals could be harmed if they become entangled in or ingest debris. Although the intentional discharge of marine debris is prohibited by law, the potential exists for the inadvertent discharge of such debris. Similar impacts on non-threatened and non-endangered marine mammals would be expected. Impacts would be similar to those described for ESA-listed marine mammals under impacts of construction above. All vessels would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent inadvertent release of debris, making such impacts on ESA-listed marine mammals unlikely to occur, and thus discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, impacts associated with the ingestion of marine debris may affect but are not likely to adversely affect ESA-listed marine mammals in the offshore project footprint.

Entanglement

Impacts would be similar to those described under construction and would be discountable. The design of the TYMS makes it unlikely for any entanglement to occur. The design of the service vessel moorings includes anchor lines in the water column; however, marine mammals would be unlikely to become entangled because of the large size of the lines and given the distance to where ESA-listed whales are likely to occur, located approximately 80 miles south of the proposed Port location. All vessels would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials including items that could cause entanglement. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent sources of entanglement, making the likelihood of such impacts on ESA-listed marine mammals during operations extremely low, and thus discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, impacts associated with entanglement may affect but are not likely to adversely affect ESA-listed marine mammals.

Lighting

Impacts would be similar to those described under construction. Therefore, potential impacts from lighting would have no effect on ESA-listed marine mammals.

Alteration to Prey Species Abundance and Distribution

Impacts would be similar to those described under construction. Therefore, potential impacts from alteration to prey species would have no effect on ESA-listed marine mammals.

Air Emissions

No impacts are expected to non-listed marine mammals from air emission affects. Therefore, potential impacts from air emissions would have no effect on ESA-listed marine mammals.

Impacts of Decommissioning

Short-term direct minor adverse effects to the marine environment near the proposed Project site, which supports ESA-listed marine mammal species, are expected in connection with decommissioning of the terminal. The proposed terminal is designed for a 30-year life. Decommissioning may involve the removal of all offshore structures and leaving in place pipelines and other structures below ground. The decommissioning procedure would be a reversal of the installation procedure. The proposed pipeline facilities would be decommissioned in place following termination of their service. Decommissioning of the proposed pipelines facilities would consist of purging the pipe of gas and filling it with seawater, cutting all piping at the mud line, and removing risers, platforms and associated equipment. Such activities would cause sediment displacement and the temporary increased water turbidities. It is expected that no blasting would be required for removing mooring structures during decommissioning. Typically, piles are cut at or below the ocean bottom, with infrastructure removed and transported back to shore.

It is expected that the proposed Port would be in operation for at least 30 years. Potential impacts on ESA-listed marine mammal resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time. However, as discussed for construction, impacts are generally expected to be insignificant or discountable; therefore, impacts from decommissioning may affect but are not likely to adversely affect ESA-listed marine mammals.

4.3.1.2 Threatened and Endangered Sea Turtles

ESA-listed turtles occur in the proposed Project footprint as does loggerhead turtle critical habitat (Figure 3.3-1). For a discussion on potential impacts to marine vegetative communities (*Sargassum* critical habitat), see Section 4.3.5. Proposed Project activities would not destroy or adversely modify *Sargassum* critical habitat for the loggerhead sea turtle.

Impacts of Construction

In general, construction impacts as described for ESA-listed marine mammals can be directly applied to sea turtles, including vessel traffic, ingestion of marine debris, entanglement, alteration to prey species abundance and distribution, and air emissions. Please refer to Section 4.3.1.1 for detailed discussion of construction impacts. Impacts specific to sea turtles that may differ from the discussion of ESA-listed marine mammals are provided below.

Noise

Short-term, moderate, adverse impacts on ESA-listed sea turtles would result from noise generated during proposed Port construction, similar to those impacts already described in Section 4.3.11. Sound sources of underwater construction noise associated with the proposed Port include impact pile driving (from anchor pile installation, if in the unlikely event geotechnical conditions preclude use of suction anchors), proposed WC 167 bypass and pipeline lateral installation, and support vessels. A more detailed discussion of underwater noise resulting from each of these construction activities associated with the proposed Port is provided in Section 4.10.1.

In general, impacts from noise associated with proposed Project construction in the Action Area and ROI on sea turtles would be as previously described for ESA-listed marine mammals (see Section 4.3.1.1). Although NOAA Fisheries has not yet established acoustic thresholds for effects to sea turtles, studies have been directed through the U.S. Navy and other organizations to analyze acoustic and explosive effects to sea turtles (Finneran and Jenkins 2012). Several studies using green, loggerhead, and Kemp's ridley turtles suggest that sea turtles are most sensitive to low-frequency sounds (Bartol and Ketten 2006; Bartol et al. 1999; Lenhardt 1994; Ridgway et al. 1969). Hearing sensitivity can vary slightly by species and age class; however, because of the similarities across the data that are available, sea turtles are placed within a single functional hearing group (Finneran and Jenkins 2012).

Criteria for sea turtles are divided into physiological effects and behavioral effects (Finneran and Jenkins 2012). Physiological effects criteria and thresholds are based on TTS and PTS, similar to marine mammals. Behavioral thresholds are based on experimental and observational data documenting the reactions of sea turtles to sound.

As of 2012, no known data are available on potential hearing impairments (i.e., TTS and PTS) in aquatic turtles (Finneran and Jenkins 2012). Sea turtles, based on their auditory anatomy are believed to have lower absolute sensitivity, and thus higher thresholds, as compared to cetaceans (Bartol and Musick 2003; Lenhardt et al., 1985; Wartzok and Ketten 1999; Wever 1978; Wyneken 2001).

Since sea turtles have best sensitivity at low frequencies, similar to the low frequency cetaceans, the low frequency cetacean TTS threshold has been applied to sea turtles. Therefore, the TTS threshold for sea turtles exposed to sonars and other active acoustic sources is a (Type I) weighted SEL of 178 dB re 1 $\mu Pa^2/sec$ (Finneran and Jenkins 2012). As with the marine mammals, the PTS threshold for sea turtles exposed to sonars and other active acoustic sources is estimated as being 20 dB above the TTS threshold.

This results in a PTS threshold consisting of a (Type I) weighted SEL of 198 dB re 1 $\mu Pa^2/sec$. Finneran and Jenkins (2012) report that potential sea turtle behavioral changes can include a startle reaction, avoiding the sound source, increased swimming speed, increased surfacing time, and decreased foraging. There are several studies that have investigated the behavioral responses of sea turtles to impulsive sounds produced by seismic airguns. O'Hara and Wilcox (1990) reported that loggerhead turtles kept in a 300- × 45-m enclosure in a 10-m-deep canal maintained a standoff range of 30 m from three small airguns fired simultaneously at 15-second internals. Although O'Hara and Wilcox did not report the actual received sound levels, McCauley et al. (2000) have estimated the received sound pressure level (SPL) for avoidance to be 175–176 dB re 1 µPa. McCauley et al. (2000) measured behavioral responses in captive green and loggerhead turtles exposed to airgun impulses. Their results showed that at sound levels above a received SPL of 166 dB re 1 µPa the turtles noticeably increased their swimming activity compared to non-airgun operational periods. Above 175 dB re 1 µPa, behavior became more erratic, possibly indicating that the turtles were in an agitated state (McCauley et al. 2000). The authors noted that the point at which the turtles showed the more erratic behavior would be expected to approximately equal the point at which avoidance would occur for unrestrained turtles (McCauley et al. 2000).

There is scarce information regarding hearing and acoustic thresholds for marine turtles. The most recent criteria from Popper et al. (2014) do not provide numerical TTS or behavioral threshold criteria for sea turtles but rather provide subjective standards of "low, medium, and high" risk for turtles that are "near, intermediate, or far" from a continuous noise source. However, for impulsive sources, Popper et al. (2014) estimates injury threshold levels of 210 dB re 1 µPa (cSEL) and 207 dB re 1 µPa (SPL_{pk}). Sea turtle hearing thresholds in water have not been established by NOAA Fisheries. Avoidance reactions to seismic sources have been documented in caged turtles at levels between 166 and 179 dB re 1 µPa (Moein et al. 1995; McCauley et al. 2000). Popper et al. (2014) estimates that the potential for TTS, masking, and behavioral alterations is high for exposures occurring near (within tens of meters from) the source; and low for exposures occurring at intermediate (hundreds of meters) and far (thousands of meters) from the source. Sea turtle underwater acoustic injury and behavioral thresholds of 207 dB re 1 µPa and 166 dB re 1 µPa, respectively (Table 4.3-8), have been used in NOAA Fisheries Biological Opinions (NOAA Fisheries 2015v) and are applied in these analyses. No distinction is made between impulsive and continuous sources for these thresholds.

Based on the modeling methodology and scenario described in Section 4.3.1.1, estimated construction noise impacts on sea turtles for pile-driving and thruster vessels are as summarized in Table 4.3-8 and Figure 4.3-2.

Table 4.3-8. Estimated Distances to Sea Turtle Threshold Levels during Construction

Noise Modeling Scenario	Distance to Injury Onset (m)	Distance to Behavioral Reaction Onset
Pile Driving	0	341
Offshore Supply Vessel Thrusters (Construction Scenario)	0	686

Based on this information, it is predicted that protection of sea turtles from noise associated with pile driving and the offshore supply vessel would be addressed through consideration and mitigation for thresholds established for marine mammals, and impacts to sea turtles would likely be insignificant with mitigations in place. While the potential for take may exist, all recommendations from Federal and State consulting agencies would be followed to avoid and monitor impacts to sea turtles. To prevent Level A take and minimize the potential for Level B take, Delfin LNG would implement mitigations as listed in Section 4.3.10 that include measures such as, but not limited to, use of lowest noise-producing impact hammer available, use of a cofferdam system (including the introduction of bubbles within the annulus between the pile and the cofferdam to reduce the transmission of marine noise), use of the pile-driving soft start ramp-up procedures preceded by clearing the surrounding waters by a PSO, and call for a suspension of pile driving by the PSO should a protected species be observed in proximity to the active pile driving operation. Likewise, the Applicant has committed to the minimal safe operating power for vessels to be maintained at all times, and DP thrusters will not be engaged unless required. Thruster power will also be reduced to the absolute lowest safe operating levels if sea turtles are detected within 500 m of a DP vessel, and other vessels in the immediate vicinity would be instructed to reduce to slow speed and minimum safe operating power consistent with the operations being performed. To prevent Level A take and minimize the potential for Level B take, Delfin LNG will implement the standard mitigations for sea turtle monitoring during activities, as stated in Section 4.3.10. With mitigations in place, operation noise impacts may affect but are not likely to adversely affect sea turtles.

Lighting

Lighting from proposed Port construction is not expected to have an adverse effect on sea turtles. Light pollution on nesting beaches is detrimental to sea turtles because it alters critical nocturnal behaviors such as nest site selection, return to sea post-nesting, and hatchling entry to the sea (Witherington and Martin 1996). The USFWS and NOAA Fisheries have indicated that the lights on similar project may attract hatchling sea turtles, exposing them to risk of impingement on the intake screens for required water intakes. However, the proposed construction area would be located over 100 miles from the Chandeleur Islands, the closet known sea turtle nesting site. As a result, sea turtle hatchlings are not expected to encounter construction vessels and lighting from the DOF portion of the proposed Project is not expected to affect nesting adults. Any potential impacts would be insignificant and discountable. In addition, hatchling and juvenile threatened and endangered sea turtles are not expected to occur regularly in the Action Area and ROI due to their preference for traveling in *Sargassum* mats or utilizing more shallow and coastal habitats. However, if hatchling and juvenile sea turtles become attracted to the proposed construction light sources, they would be vulnerable to increased predation. Lighting associated with nearshore platforms has been known to disrupt offshore migrations of neonates; however, the proposed construction area is sufficiently far offshore, and activities limited in duration, so that impacts from construction vessel lighting would be insignificant and discountable. Therefore, the impacts described above may affect but are not likely to adversely affect ESA-listed sea turtles.

Impacts of Operation

In general, proposed Port operational impacts as described for ESA-listed marine mammals in the Action Area and ROI can be directly applied to sea turtles, including benthic habitat impacts, turbidity, ballast water discharge, accidental release of fuel, oil and other chemicals, LNG spills, maintenance and repair, vessel traffic, ingestion of marine debris, entanglement, alteration to prey species abundance and distribution and air emissions. Please refer to Section 4.3.1.1 for detailed discussion of operational impacts. Impacts specific to sea turtles that may differ from the discussion of ESA-listed marine mammals are provided below.

As a result, any additions from noted parameters would be de minimis and would not affect ESA-listed sea turtles. Treated discharged would meet all USEPA and USCG requirements and are thus not expected to affect sea turtles to any significant degree.

Noise

During routine Port operations, transient noise would be generated by LNGCs and support vessels within the Action area and ROI. With the use of LNGCs, effects from operation noise are expected to be long-term, moderate, with the potential for adverse effects on sea turtles. Operation noise outputs have the potential to result in levels exceeding Level A take, as described in Section 4.3.1.1, on species in the area if they were within the zone of acoustic influence since levels would exceed NOAA's guidance levels for acoustic take. They would also exceed the levels established for sea turtles, since sea turtles have best sensitivity at low frequencies, similar to the low frequency cetaceans, so the low frequency cetacean TTS threshold has been applied. Therefore, the TTS threshold for sea turtles exposed to sonars and other active acoustic sources is a (Type I) weighted SEL of 178 dB re 1 μPa^2/sec (Finneran and Jenkins 2012). As with the marine mammals, the PTS threshold for sea turtles exposed to sonars and other active acoustic sources is estimated as being 20 dB above the TTS threshold and are expected to result in Level B take.

Based on the modeling approach described in Section 4.3.1.1 and operations scenario described in Section 4.3.1.2, estimated operational vessel noise impacts on sea turtles are summarized in Table 4.3-9 and Figure 4.3-3.

Table 4.3-9. Estimated Distances to Sea Turtle Threshold Levels for Vessel Thrusters during Operation

Noise Modeling Scenario	Distance to Injury Onset (m)	Distance to Behavioral Reaction Onset
Vessel Thrusters (Operations Scenario)	0	746

Effects to sea turtles from loud noise sources during operations would be expected to be similar to those described above for construction noise, particularly with regard to vessel noises. Impacts from operation noise activities are expected to be mitigatable on sea turtles in the proposed Project area. The marine mammals known to occur inshore can avoid the noise because they are highly mobile. Sea turtles are seasonal and unlikely to be collocated with the proposed Project noise sources. In addition, the amount of noise created by vessel operations would be negligible when compared to ambient noise levels in the ROI. Furthermore, noise from operational activities would be short-term in duration and moderate in intensity. Therefore, long-term, major, adverse impacts on sea turtles would not be expected, and would be insignificant with mitigations in place. While the potential for take may exist, all recommendations from Federal and State consulting agencies would be followed to avoid and monitor impacts to sea turtles. As detailed in Section 4.3.10, the Applicant has committed to the minimal safe operating power for FLNGVs to be maintained at all times, and DP thrusters will not be engaged unless required. Thruster power will also be reduced to the absolute lowest safe operating levels if marine mammals or sea turtles are detected within 500 m of an FLNGV, and other vessels in the immediate vicinity would be instructed to reduce to slow speed and minimum safe operating power consistent with the operations being performed. To prevent Level A take and minimize the potential for Level B take, Delfin LNG will implement the standard mitigations for marine mammal monitoring during operations, as stated in Section 4.3.10. With mitigations in place, operation noise impacts may affect but are not likely to adversely affect marine mammals.

Lighting

The proposed terminal lighting is not expected to have an adverse effect on sea turtles. Light pollution on nesting beaches is detrimental to sea turtles because it alters critical nocturnal behaviors such as nest site selection, return to sea post-nesting, and hatchling entry to the sea (Witherington and Martin 1996). The USFWS and NOAA Fisheries have indicated that the lights on similarly proposed terminals may attract hatchling sea turtles, exposing them to risk of impingement on the intake screens for ballast water other required water intakes. However, the proposed terminal site would be located over 100 miles from the Chandeleur Islands, the closet known sea turtle nesting site. As a result, sea turtle hatchlings are not expected to encounter the terminal and lighting from the DOF portion of the proposed Project is not expected to affect nesting adults. Any potential impacts would be insignificant and discountable. In addition, hatchling and juvenile threatened and endangered sea turtles are not expected to occur regularly in the Action Area and ROI due to their preference for traveling in *Sargassum* mats or utilizing more shallow and coastal habitats. However, if hatchling and juvenile sea turtles become attracted to the proposed Project light sources, they would be vulnerable to increased predation. Lighting associated with nearshore platforms has been known to disrupt offshore migrations of neonates; however, proposed terminal is sufficiently far offshore so that impacts would be negligible. Therefore, the impacts described above may affect but are not likely to adversely affect ESA-listed sea turtles.

Impacts of Decommissioning

Short-term direct minor adverse effects to the marine environment near the proposed Project site, which supports sea turtles, are expected in connection with decommissioning of the terminal. The proposed terminal is designed for a 30-year life. Decommissioning may involve the removal of all aboveground structures and leaving in place facilities below ground. The decommissioning procedure would be a reversal of the installation procedure. The proposed pipeline facilities would be decommissioned in place following termination of their service. Decommissioning of the proposed pipelines facilities would consist of purging the pipe of gas and filling it with seawater, cutting all piping at the mud line, and removing risers, platforms and associated equipment. Such activities would cause sediment displacement and the temporary increased water turbidities. It is expected that no blasting would be required for removing mooring structures during decommissioning. Typically, piles are cut at or below the ocean bottom, with infrastructure removed and transported back to shore.

Impacts from routine discharges; accidental releases of fuel, oil, and other chemicals; noise; increased vessel traffic; ingestion of marine debris; and entanglement would be similar to construction activities within the Action Area and ROI described for ESA-listed marine mammals. It is expected that the proposed Port would be in operation for at least 30 years. Potential impacts on sea turtle resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time. However, as discussed for construction, impacts are generally expected to be insignificant or discountable; therefore, impacts from decommissioning may affect but are not likely to adversely affect ESA-listed sea turtles.

4.3.1.3 Threatened and Endangered Birds

Migratory birds are expected to occur within the proposed Project area, although natural communities where migratory birds are expected to breed are generally minimal. Migratory birds may be directly impacted in the Action Area if nests, nestlings, or adults are disturbed during construction or operations, especially during breeding seasons. Impacts may result from construction noise, vegetation clearing, ground disturbance, and staging activities. Coastal and marine birds generally remain on or above the sea surface unless diving for food; therefore, these species would not be expected to be affected by activities such as the installation of seabed components, increased turbidity plumes, or water intakes and discharges. Surface activities that could affect coastal and marine birds during construction, operation, and decommissioning of the proposed Project would include increased vessel traffic, nighttime lighting, gas flaring, noise, and accidental spills. These aspects of the proposed Project would be expected to result in short-term, minor adverse impacts on coastal and marine birds and less than significant impacts.

Impacts of Construction

Construction of the proposed Port would cause short-term, minor, adverse effects and less than significant impacts on coastal, marine, and migratory birds. Impacts would be caused by increased vessel traffic, noise, marine debris, and lighting.

Benthic Habitat

Negligible impacts on coastal, marine, and migratory birds would be expected as a result of benthic habitat disturbance during construction. Birds occurring in the ROI primarily occupy the airspace above the proposed Project, the water surface, or in the upper portions of the water column during foraging. Few seabird species forage on or near the seafloor. The amount of subsea habitat that would be altered as a result of the proposed Port represent only a very small proportion of the subsea habitat available in similar water depths. The proposed Port is not likely to have adverse impacts on birds as a result of alterations to seafloor habitat because of the small footprint on the seafloor and impacts on seafloor habitat would be short-term (i.e., the benthic environment would revert to pre-installation conditions) and insignificant. Therefore, impacts from alterations of the seafloor may affect but are not likely to adversely affect ESA-listed birds.

Turbidity

Short-term, minor impacts on coastal, marine, and migratory birds would be expected as a result of increased turbidity during construction. Turbidity has the potential to impact birds foraging in the water column by reducing visibility, which could potentially affect underwater movement or prey capture. An increase in turbidity would be localized in nature and only be conducted for a short-term during the construction phase of the proposed Project. Because of this, adverse effects on ESA-listed birds from turbidity are expected to be short-term, negligible, and insignificant. Therefore, impacts from turbidity may affect but are not likely to adversely affect ESA-listed birds.

Routine Discharges

Routine discharges are not likely to adversely affect coastal, marine, and migratory birds. The proposed Project area is not expected to contain habitat that concentrates avian activity in any one area more than any other; therefore, there is no displacement or direct harm to avifauna expected from routine discharges. If a small area was impacted by routine discharge, it is unlikely that birds would be displaced or precluded from important foraging, resting, or migrating habitat. The discharges would dissipate, and avifaunae could easily avoid unfavorable conditions. Routine discharge would not be of a magnitude that would be likely to cause harm to birds and would be insignificant and discountable. Therefore, impacts from construction discharges may affect but are not likely to adversely affect ESA-listed birds.

Accidental Releases of Fuel, Oil, and Other Chemicals

Adverse direct impacts on coastal, marine, and migratory birds would be expected from accidental releases of fuel, oil, and other chemicals. The degree of impact is directly proportional to the amount of spill and how long it continues. Oil spills pose a risk to seabirds through direct contamination and destruction of nesting, roosting, and foraging habitats (USEPA 1999b). Most petroleum products that would be carried on the construction vessels would be light, remaining on the surface of the water and evaporating in the event of a spill. These spills would be expected to adversely affect any coastal, marine, and migratory birds in the area that are collocated with the toxins. Heavier petroleum products that create a sheen and remain on the water's surface could affect marine birds landing on or diving through the water's surface for food. Birds coated with petroleum products would become limited in their flying abilities, which in turn impacts their ability to avoid predators, detect food, breathe, and reproduce. The overall impact from an inadvertent spill on coastal, marine, and migratory birds would be adverse, direct, and are expected to be short-term; however, such events would be unlikely and discountable, particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. Therefore, impacts from accidental spills may affect but are not likely to adversely affect ESA-listed birds in the proposed Port footprint.

As discussed in Section 4.2.2.2, Delfin LNG would prepare an FRP that addresses the potential for petroleum-based spills and describes preventive and response measures that would be implemented in the event of a spill. It is expected that with the FRP, immediate response actions could reduce impacts, if they occur, on ESA-listed bird populations to temporary.

Noise

Short-term, moderate impacts on coastal, marine, and migratory birds in the Action area and ROI would be expected as a result of noise during construction. Increases in ambient sound levels may cause disturbance to birds resulting in avoidance behavior from proposed existing UTOS/HIOS pipeline system and pipeline lateral installation, and construction vessel transit. Potential impacts of noise during the installation of the proposed Project on avifauna in the area may include temporary displacement or short-term disruption of normal behavior patterns (Drewitt and Langston 2006).

In the offshore environment, a limited amount of validated research on displacement effects of noise on seabirds and other avian species using the marine environment makes predicting the level of impact from proposed Project construction and operation difficult (Stewart et al. 2005). Researchers have documented a range of bird behavioral responses to noise, including no response, alert behavior, startle response, flying or swimming away, diving into the water, and increased vocalizations (National Park Service 1994; Larkin et al. 1996; Pytte et al. 2003; Plumpton 2006). While they are difficult to measure in the field, some of these behavioral responses are likely accompanied by physiological responses, such as increased heart rate or stress. European studies suggest that disturbance and avoidance impacts may occur up to 2.2 nautical miles from offshore construction sites (BOWind 2008). However, avoidance behavior as a result of construction activities is typically short in duration, and is highly unlikely to result in reduced population fitness or individual injury or mortality and would be insignificant (BOWind 2008). Therefore, impacts from construction noise may affect but are not likely to adversely affect ESA-listed birds.

Vessel Traffic

Short-term, negligible impacts on coastal, marine, and migratory birds in the Action Area and ROI would be expected from increased vessel traffic during proposed Port construction. Construction of the proposed Port would result in a slight increase in vessel traffic. Vessel traffic associated with offshore construction would not result in a substantial increase in vessel traffic above current levels and would be similar in nature to other commercial vessel and recreational traffic currently occurring in the proposed Project area. Large vessels would only likely be mobilized/demobilized to the construction site once, whereas smaller vessels may transit the proposed Project multiple times. During the day, birds are able to detect and avoid vessels, which reduces the probability that vessel strikes would impact seabird populations. Depending on the lighting scheme of the vessel, the potential of a night collision is possible. Therefore, disturbance or displacement associated with increased vessel movement is insignificant and discountable. Impacts from construction vessel traffic may affect but are not likely to adversely affect ESA-listed birds. However, to ensure safety during nighttime operations, all construction support vessels would be lit and marked in accordance with USCG requirements. As discussed further in the following sections, research has demonstrated that steady burning lights can attract birds (Gehring et al. 2009). For this reason, downshielded lights (also known as hooded lights) would be used, where possible, on construction vessels.

Ingestion of Marine Debris

Short-term, negligible, direct impacts on coastal, marine, and migratory birds would be expected from marine debris. Marine debris could be lost from any vessel involved in construction of the proposed Project. Ingestion of plastic marine debris due to pollution is a known stressor for seabirds (North American Bird Conservation Initiative 2009; Onley and Scofield 2007; Waugh et al. 2012; Weimerskirch 2004). Plastic marine debris can lead to blockage within the digestive system, internal damage, or accumulation of toxins present in the debris. Ingestion of accidentally released marine debris could result in harm to some birds; however, the impact of releasing potentially small amounts of marine debris into the environment is unlikely to have long-term, adverse impacts on coastal, marine, and migratory birds. Impacts on coastal, marine, and migratory birds would be mitigated through adherence to existing statutes that regulate marine debris. Further, as a standard operating procedure, all vessels associated with the proposed Project would be prohibited from dumping trash of any kind. All construction operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent inadvertent release of debris making such impacts on ESA-listed birds insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. This combination of proposed Project policy and existing regulations would ensure that any marine debris accidentally expended within the proposed Project area would be negligible. Therefore, impacts from the ingestion of marine debris may affect but are not likely to adversely affect ESA-listed birds.

Entanglement

Birds are known to become entangled in artificial materials at sea (North American Bird Conservation Initiative 2009; Onley and Scofield 2007; Waugh et al. 2012; Weimerskirch 2004). However, adverse impacts on birds from the proposed Port are unlikely because anchor lines securing the derrick/lay barge would be large in diameter, knotless, non-floating, and taut, and would only be deployed for a short period of time, and are thus unlikely to entangle avifauna. In addition, all construction operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials including items that could cause entanglement. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent sources of entanglement, making such impacts such impacts on ESA-listed birds insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, impacts from entanglement may affect but are not likely to adversely affect ESA-listed birds.

Lighting

Lighting has been shown to be a concern for trans-Gulf of Mexico migratory birds. Many neotropical birds migrate from Mexico to North American by crossing the Gulf of Mexico nonstop over 575 miles (500 nautical miles; 925.4 km) of open water in the spring (and the reverse in autumn). The proposed terminal would be located in the heart of this migratory pathway; thus, many of these trans-Gulf of Mexico migrants may encounter the proposed terminal. These birds are known to be attracted to artificial lighting on offshore facilities, and artificial light can seriously disrupt birds' migration patterns. Studies have shown that hundreds of thousands of birds die from oil and gas platform lighting effects in the Gulf of Mexico every year. A study by Van de Laar (2007) examined oil and gas platform lighting impacts on birds in the North Sea. One mitigation measure proposed was the use of alternative lights using specific wavelengths. The study proposed that using green lighting at platforms—as opposed to red or white lights—would nearly eliminate the circling behavior. Another study, Poot et al. (2008), showed similar findings indicating that the strongest bird responses were found in white light, which seems to interfere with visual orientation. The artificial light becomes a strong false orientation cue, and birds can be trapped by the beam. The bird responses observed in the colored-light conditions were similar to those of previous studies in the laboratory where red light caused disorientation, but it was found that green light caused no, or only minor disturbance of orientation. Delfin LNG proposes to take all measures possible to minimize the amount of total lighting used on the proposed terminal to that required for safety. Additionally, the amount of light should be minimized during the height of the trans-migratory period. To reduce the disruptive effects of lighting, all lighting at the terminal should be downshielded to keep the dispersion of light to a minimum. The shields would prevent the lights from shining skyward, instead directing the light to shine only on work areas. Shielded lighting has resulted in significant reductions in bird mortality (Evans Ogden 2002; Orr et al 2013). A heliport is proposed for the FLNGVs; Delfin LNG would install lighting on the heliport in accordance with USFWS guidelines for aviation safety lights. These guidelines specify that only white or red strobe lights should be used at night and that these strobes should be minimal in number, intensity, and number of flashes. Compliance with the above steps and guidelines would render any lighting impacts to ESA-listed birds insignificant and discountable. Therefore, impacts from construction lighting may affect but are not likely to adversely affect ESA-listed birds.

Impacts of Operation

Operation of the proposed Port could cause short-term, minor, adverse effects and less than significant impacts on coastal, marine, and migratory birds. Impacts would be caused by increased vessel traffic, marine debris, and lighting.

Benthic Habitat

Impacts on benthic resources and habitat are discussed in Section 4.2.2.1. As stated above, birds occurring in the proposed Project area primarily occupy the airspace above the proposed Project, the water surface, or in the upper portions of the water column during foraging. Few seabird species forage on or near the seafloor. Grebes, loons, and some sea duck species are capable of diving to the seafloor during feeding; however, these birds typically dive only to approximately 90 ft. No additional seafloor habitat would be altered during proposed Project operation. Therefore, the alteration of benthic habitat would have no effect on ESA-listed birds.

Turbidity

Long-term, minor impacts on coastal, marine, and migratory birds would be expected as a result of increased turbidity during operation. Turbidity has the potential to impact birds foraging in the water column by reducing visibility, which could potentially affect underwater movement or prey capture. Potential turbidity would likely be minimal given the water depth, localized, and intermittent throughout the proposed Project life. Because of this, adverse effects on ESA-listed birds from turbidity are expected to be negligible and insignificant. Therefore, impacts from turbidity may affect but are not likely to adversely affect ESA-listed birds.

Routine Discharges

As discussed above, the routine vessel discharges during proposed Port operation would be unlikely to result in adverse impacts on coastal, marine, and migratory birds. Routine discharges would include deck runoff from the FLNGV and support vessel and engine cooling water from the support vessel. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from the marine vessels would comply with USCG requirements and their requirements. If a small area of the proposed Project was impacted by routine discharge, it is unlikely that birds would be displaced or precluded from important foraging, resting, or migrating habitat. The discharges would dissipate, and avifaunae could easily avoid unfavorable conditions. Routine discharge would not be of a magnitude that would be likely to cause harm to birds and would be insignificant and discountable. Therefore, impacts from routine discharges may affect but are not likely to adversely affect ESA-listed birds

Accidental Releases of Fuel, Oil, and Other Chemicals

Adverse direct impacts on coastal, marine, and migratory birds would be expected from accidental releases of fuel, oil, and other chemicals. The degree of impact is directly proportional to the amount of spill and how long it continues. Impacts could be short-term if the spill is minor, or adverse and significant and not mitigatable if the spill is major. Oil spills pose a risk to seabirds through direct contamination and destruction of nesting, roosting, and foraging habitats (USEPA 1999b). Most petroleum products that would be carried on the construction vessels would be light, remaining on the surface of the water and evaporating in the event of a spill. These spills would be expected to adversely affect any coastal, marine, and migratory birds in the area that are collocated with the toxins. Heavier petroleum products that create a sheen and remain on the water's surface could affect marine birds landing on or diving through the water's surface for food. A model was developed using NOAA's Automated Data Inquiry for Oil Spills (known as ADIOS) to predict the dissipation rate of the maximum most probable discharge of 2,500 barrels (105,000 gallons) of fuel oil. Dissipation was rapid; the amount of time it took to reach concentrations of less than 0.05 percent varied between 0.5 and 2.5 days, depending on ambient wind. Concentrations of less than 0.5 percent occurred within 44 hours with 10-knot winds and within 11 hours with 20-knot winds. Birds coated with petroleum products would become limited in their flying abilities, which in turn impacts their ability to avoid predators, detect food, breathe, and reproduce. The overall impact from an inadvertent spill on coastal, marine, and migratory birds would be adverse, direct, and short-term; however, such events would be unlikely and discountable, particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. Therefore, impacts from accidental spills may affect, but are not likely to adversely affect ESA-listed coastal and marine birds in the proposed Port footprint.

As discussed in Section 4.2.2.2, Delfin LNG would prepare an FRP that addresses the potential for petroleum-based spills and describes preventive and response measures that would be implemented in the event of a spill. It is expected that with the FRP, immediate response actions could reduce impacts, if they occur, on ESA-listed bird populations to temporary.

LNG Spills

Short-term, minor, direct adverse impacts on coastal, marine, and migratory birds could occur in the unlikely event of an LNG spill; however, such events would be unlikely and discountable particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. All FLNGVs are designed with features to minimize the potential for LNG spills (see Section 2.2.6). However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in injury or death and asphyxiation by natural gas vapors above the surface of the water. These impacts would likely occur in the immediate vicinity of the spill location and the time frame of the impact would be expected to be limited. Since LNG would boil off as natural gas at the surface, depth, and pressure required for gas to dissolve (Artemov et al. 2005) in surface waters would not be sufficient and gas vapors would disperse. Therefore, the time frame for these impacts would be limited, and adverse toxic impacts would be expected to be minor after the LNG boiled off and the vapors dispersed.

The potential for a release of natural gas from the proposed existing UTOS/HIOS pipeline system and pipeline laterals are remote and discountable. If there were a subsea release of natural gas, the gas would rise to the water surface rapidly and dissipate. In general, whether a release is sudden or extended, physics dictate that any methane would gradually dissolve into the water column during the lifetime of the bubble as described by Fick’s law, taking into account Henry’s law constants, partial pressure, and concentrations of dissolved gases (Artemov et al. 2005). Once a gas bubble reaches the surface, it would rise (being lighter than air) and be dispersed by air currents. Coastal, marine, and migratory bird impacts from such a release would be short-term and minor; therefore, impacts from potential LNG spills may affect, but are not likely to adversely affect ESA-listed coastal and marine birds in the proposed Port footprint.

Planned and Unplanned Maintenance and Repair

Beyond typical impacts associated with vessel transits, including intake and discharge of water, and the risk of vessel strike, as discussed above, no adverse impacts on coastal, marine, and migratory birds are expected to occur as a result of maintenance and repair activities during operation. During the operational period, maintenance of the pipeline would include pigging to periodically clean out residual materials. The release of these materials into the surrounding environment can lead to water quality impacts and contamination of adjacent benthic habitats. However, due to the expected short duration of these impacts, if they occur, no significant negative effects on marine populations within the proposed Project area are expected. It is anticipated that such internal inspections would be conducted approximately once every seven years and impacts would be discountable. Therefore, the impacts from maintenance and repair may affect but are not likely to adversely affect ESA-listed marine mammals.

Noise

Long-term, minor, adverse impacts on coastal, marine, and migratory birds in the Action Area and ROI could occur as a result of increased airborne noise levels generated during operation. Such impacts could displace birds from the area. Bird species with coastal distribution would not be affected by noise during operation, as it is unlikely that noise generated by operation would reach coastal areas. Bird use at the propose Port would be intermittent and not common. Offshore birds are very mobile and have other habitat in the area so noise would have no effect on ESA-listed birds.

Vessel Traffic

As stated above, the vessel traffic associated with operation would result in a negligible increase in vessel traffic above current levels and would be similar in nature to other commercial vessel and recreational traffic currently occurring in the proposed Project area. The impacts of vessel movements in the Action Area and ROI would be expected to be short-term with disturbances of individual birds in the vicinity expected. Therefore, disturbance or displacement associated with increased vessel movement is unlikely and vessel traffic would have no effect on ESA-listed birds. However, to ensure safety during nighttime operations, all vessels would be lit in a manner to minimize impacts on birds (downshielding), but marked in accordance with USCG requirements.

Ingestion of Marine Debris

Short-term, minor, adverse impacts on coastal, marine, and migratory birds would be expected from accidental release of marine debris during construction. Marine debris could be lost from any vessel involved in operation of the proposed Port. Ingestion of plastic marine debris due to pollution is a known stressor for seabirds (North American Bird Conservation Initiative 2009; Onley and Scofield 2007; Waugh et al. 2012; Weimerskirch 2004). Plastic marine debris can lead to blockage within the digestive system, internal damage, or accumulation of toxins present in the debris. Ingestion of accidentally released marine debris could result in harm to some birds; however, the impact of releasing potentially small amounts of marine debris into the environment is unlikely to have long-term, adverse impacts on coastal, marine, and migratory birds. Impacts on coastal, marine, and migratory birds would be mitigated through adherence to existing statutes that regulate marine debris. Further, as a standard operating procedure, all vessels associated with the proposed Port would be prohibited from dumping trash of any kind. All operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent inadvertent release of debris making such impacts on ESA-listed birds insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. This combination of proposed Project policy and existing regulations would ensure that any marine debris accidentally expended within the proposed Project area would be short-term and minor. Therefore, impacts from the ingestion of marine debris may affect but are not likely to adversely affect ESA-listed birds.

Entanglement

As stated above, birds are known to become entangled in artificial materials at sea (North American Bird Conservation Initiative 2009; Onley and Scofield 2007; Waugh et al. 2012; Weimerskirch 2004). However, the design of the TYMS makes it unlikely for any entanglement to occur. The design of the service vessel moorings includes anchor lines in the water column. Birds diving for prey would be unlikely to become entangled because of the large size of the lines. In addition, all operations would need to be in compliance with MARPOL Annex V and other applicable regulations set forth to minimize the risk of inadvertent release of materials including items that could cause entanglement. Compliance with all Federal safety and environmental requirements and MARPOL guidance would prevent sources of entanglement, making such impacts such impacts on ESA-listed birds insignificant and discountable. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. Therefore, impacts from entanglement may affect but are not likely to adversely affect ESA-listed birds

Lighting

Short-term, minor direct impacts on coastal, marine, and migratory birds would be expected from artificial lighting associated with operation. Artificial lighting associated with vessels and offshore oil and gas platforms in offshore environments are known to attract both marine birds and terrestrial species and in some cases have caused some fatalities, particularly during poor weather conditions (Merkel and Johansen 2011). Lights on FLNGVs and the support vessel could attract birds or bats migrating/moving at night through the area. Solid white lighting, which many construction vessels contain, appears more problematic for birds, especially nocturnal migrants, than other types of lights (Poot et al. 2008; Gehring et al. 2009).

Lighting used during operation would be limited to the vessels (e.g., navigation lights, spotlights, decklights) and be used to illuminate the work areas both on the vessel and on the water's surface. Precautions would be made to minimize the amount of lighting needed directly on the water surface, as appropriate, without compromising the quality or safety of the work area. Compliance with the above precautions would render any lighting impacts to ESA-listed birds insignificant and discountable. Therefore, impacts from operational lighting may affect but are not likely to adversely affect ESA-listed birds.

Gas Flaring

Impacts from active gas flaring to migratory birds and bats would be minor because the proposed Port would be located 37.4 to 40.8 nautical miles from the coastal areas where migratory birds and bats may congregate briefly during the height of the trans-migratory periods. Studies on the impacts gas flaring on birds, especially on offshore structures such as oil platforms, are limited (Ellis et al. 2015; Ronconi et al. 2015); however, gas flaring mortality events of migratory birds have been documented (Jones 1980; Mandel 2013). Such mortality events appear to occur under specific environmental conditions where precipitation, fog, and low cloud cover may force birds to fly lower and potentially within the height of a gas flaring event (Ronconi et al. 2015). Potential impacts from active gas flaring to migratory birds and bats would be minor because the proposed Port would be located 37.4 to 40.8 nautical miles from the coastal areas where migratory birds and bats may congregate briefly during the height of the trans-migratory periods; however, the amount of oil and gas infrastructure currently existing in the Gulf of Mexico would provide other alternative roosting sites for migratory birds. As nocturnal migratory birds may be drawn to the light of the flame and become disorientated, the Applicant has committed to avoid gas flaring at night, during low visibility (i.e., fog, storm events), and during peak migration (mid-March through April and September through October) to the maximum extent feasible since flares are installed to accommodate process upset conditions as well as gas venting that might be required as a result of specific maintenance and safety procedures. Any planned maintenance activities that would require flaring will be scheduled to not be conducted during night time, during periods of low visibility, and/or during peak migration periods to the maximum extent feasible. In addition, flare design will follow USFWS recommendations to install cone-shaped mesh covers on open vents of all the process vessels and storage tanks to minimize bird perching to the maximum extent feasible. The Applicant has also committed to consult regularly with the USFWS to determine the peak migration periods at the proposed Port location and will commit to monitoring for any bird mortality consistent with any recommendations from the USFWS following each flaring event. The survey should be rigorous enough to detect any use by migratory birds of the offshore LNG facility and should encompass both the spring and fall migrations. The distance of the proposed Port from shore in conjunction with compliance with the above BMPs would make impacts to ESA-listed birds from gas flaring events insignificant. Therefore, impacts from operational gas flaring may affect but are not likely to adversely affect ESA-listed birds.

Impacts of Decommissioning

Short-term direct minor adverse effects to the marine environment near the proposed Project site, which supports marine biological communities, are expected in connection with decommissioning of the terminal. The proposed terminal is designed for a 30-year life. Decommissioning may involve the removal of all aboveground structures and leaving in place facilities below ground. The decommissioning procedure would be a reversal of the installation procedure. The proposed pipeline facilities would be decommissioned in place following termination of their service. Decommissioning of the proposed pipelines facilities would consist of purging the pipe of gas and filling it with seawater, cutting all piping at the mud line, and removing risers, platforms and associated equipment. Such activities would cause sediment displacement and the temporary increased water turbidities. It is expected that no blasting would be required for removing mooring structures during decommissioning. Typically, piles are cut at or below the ocean bottom, with infrastructure removed and transported back to shore. Noise impacts would be limited to decommissioning vessels. Expected noise levels would be similar to other non-Project vessels that occur regularly in the vicinity during oil and gas operations. Potential impacts would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.3.1.4 Threatened and Endangered Fishes

As mentioned in Section 3.2.3, neither the sturgeon nor the smalltooth sawfish are expected to occur in the proposed Project vicinity. The smalltooth sawfish is restricted to the Florida peninsula. The Gulf sturgeon rarely ventures west of the Mississippi River, and is not known to travel into deeper waters characteristic of the proposed Project site. The proposed Project would have no impacts on ESA-listed fishes. Therefore, proposed Port construction, operation and decommissioning activities would have no effect on ESA-listed fishes. Section 4.3.8 provides additional detail on impacts to fisheries resources and Section 4.4 contains additional details about noise impacts on fish.

4.3.2 Marine Protected Areas

As there are no MPAs in the proposed Project footprint or the vicinity, no effects and no impacts would occur. Proposed Project impacts on biological resources are expected to be isolated within the immediate area of the proposed Port, as discussed for each in the above sections. Therefore, no adverse impacts would be expected on MPAs.

4.3.3 Marine Mammals (Non-Endangered)

Activities associated with construction and operation of the proposed Project that would impact marine mammals include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- water intake associated with FLNGV commissioning;
- vessel and aircraft noise;
- anchoring;
- artificial lighting;
- increased vessel traffic;
- marine debris;
- introduction of nonindigenous species;
- periodic pipeline maintenance; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

4.3.3.1 Impacts of Construction

During construction, impacts on non-ESA-listed marine mammals would be associated with hydrostatic test water discharges, routine discharges, accidental releases of fuel, oil, and other chemicals, noise, increased vessel traffic, ingestion of marine debris, and entanglement.

Benthic Habitat

No impacts are expected to marine mammals from benthic habitat effects.

Turbidity

Short- and long-term, and negligible impacts on non-endangered marine mammals would occur from turbidity associated with construction of the proposed Port. Plowing and jetting activities would displace bottom sediments and result in short-term water column and seafloor disturbances that have the potential to impact marine mammals. Marine mammals are mobile, and areas of turbidity are expected to be small relative to the area covered by marine mammals on a daily basis. Effects on marine mammals, if any, would take the form of either avoidance of or direct exposure to a small area of turbidity. Avoidance would be quick, would likely not be discernible from the individual's regular travel pattern, and would not be expected to result in a measurable displacement. Given that turbidity occurs naturally in the Gulf of Mexico due to wind and weather events, brief exposure to patches of turbidity would not be expected to adversely affect marine mammals. Limited information suggests that increased turbidity from construction activities, such as dredging, is unlikely to have direct impacts on marine mammals that already inhabit dark, turbid environments (Todd et al. 2014). Therefore, adverse effects on marine mammals from turbidity are expected to be both short-term and long-term, and negligible. Any individuals displaced during construction would be expected to return following construction.

Construction Support Vessel Intake and Discharges

Construction vessel intake and discharges would not result in adverse impacts on marine mammals. There would be no impacts due to impingement of marine fish resources (potential prey items) during construction activities because proposed Port intake velocities would be less than 0.5 ft/s in keeping with best technology available standards set forth in Section 316(b) regulations under the CWA. These velocities are sufficiently low enough to allow juvenile and adult fish to escape impingement and would have no effect on marine mammals.

Hydrostatic Test Water Discharge

Short-term, minor, adverse impacts on marine mammals would result from hydrostatic testing discharges during construction. Hydrostatic test water would be discharged locally into the marine habitat. Any biocide or corrosive inhibitors that would be used during hydrostatic testing would be approved for marine release by the USEPA and used in accordance with the manufacturers' instructions. These measures would minimize adverse impacts on marine mammals, and adverse impacts would be localized.

FLNGV Commissioning

Short-term, minor impacts on marine mammals would result from water intake and discharge from initial FLNGV commissioning. Once the FLNGVs have been fully commissioned, no discharges are anticipated from FLNGVs during natural gas offloading at the proposed Port facilities. Compliance with the USEPA's 1.8°F excess temperature criterion is predicted to occur within less than 90 ft of the point of discharge, which is well within the typical 328-ft regulatory mixing zone. The plume centerline temperature is predicted to drop from 18°F greater than ambient at the point of discharge to less than 1.8°F greater than ambient within approximately 30 to 90 ft downcurrent of the point of discharge. A thermal plume from water discharge may cause stress for local marine mammals; however, they would not likely be adversely affected, because the plume would be relatively small and would rapidly disperse.

Routine Discharges

Routine discharges are not routine for marine mammals in that they add pollutants and toxics to the marine habitat in which they live. Minor hydrocarbon releases of diesel fuel and various lubricants from offshore work vessels could result in negative direct impacts on marine mammals in the proposed Project footprint. Extended exposure can lead to more deleterious impacts such as reduction in birth rates, or mortality. Many factors determine the degree of damage from a spill, including the composition of the petroleum compound, the size and duration of the spill, the geographic location of the spill, and the weathering process present. Effects would depend on the nature of the toxicant, exposure time, and environmental conditions as well as on the life stage of the marine mammal exposed. Although oil is toxic to all marine organisms at high concentrations, certain species and life history stages of organisms appear to be more sensitive than others. Pregnant marine mammals and early neonates or young calves may be the most sensitive. Concentrations of oil that are diluted sufficiently to not cause acute impacts in marine fauna may alter certain behavior or physiological patterns or cause sub-lethal effects.

All construction operations that require the use of hazardous materials (e.g., heavy fuel oil, diesel) would need to be in compliance with MARPOL Annex I and Annex IV and other applicable regulations set forth to minimize the risk of accidental discharge, including an approved SPCC Plan (see Section 4.2.2.2). Also, all decks where diesel or oil spills occur would be in a confined area (surrounded by an 8-inch-high welded steel barrier). Oil/water separators would be used on the vessels and residual oil would be stored and disposed of at a shore-side dock. Thus, it is not anticipated that rainwater contaminated with petroleum products would wash over the side of the ship deck and discharges of petroleum products during construction would not be expected.

Short-term, minor, direct, adverse impacts on marine mammals from degradation of habitat (via water quality pollution) would be expected from discharges of water from construction vessels (e.g., deck drain runoff, engine cooling water, bilge water, treated sanitary wastewater, and potential oil spills). These discharges would be of limited duration and would be similar to those from other boats and barges in the ROI. Routine discharges would be localized and, thus, would be expected to impact marine mammals in close proximity to their discharge points; however, such close proximity is unlikely. The warmed seawater discharges from construction and support vessel engine cooling would consist of a small, localized, warm water plume that would be expected to return to ambient temperatures not far from the discharge point. Discharged treated domestic sanitary wastewater from construction and support vessels would be expected to be diluted within the open ocean and, thus, have short-term, minor, adverse impacts on marine mammals close to the discharge point.

Accidental Releases of Fuel, Oil, and Other Chemicals

Impacts would be identical in terms of effects with accidental releases as to routine discharges, though they are expected to be more severe in intensity due to the non-predictable nature of the discharges and lack of control over volume and extent of the spills, and lack of control of the time frame with which they may go on. Cumulative effects can occur especially in the Gulf of Mexico where the Deepwater Horizon oil spill has already changed the baseline environment for marine mammals. The proposed Project would increase tanker traffic in and around the Gulf of Mexico, exacerbating the potential for ship collisions and other accidents that could result in hazardous material spills from tankers (either their LNG cargo or their own fuel supply). Any such spills could have a negative impact on the environment of the region.

Because marine mammals require routine contact with the sea surface, these species experience high risk from impacts of floating oil sheens. Oil and gas spills can have a direct impact on marine mammals from inhalation of toxic fumes, which can lead to brain lesions, stress, and disorientation. Studies have shown that oil from spills not only causes acute short-term mortality, but that tanker accidents and the resulting spilled oil can persist in the marine environment for more than a decade, resulting in long-term impacts at a population level.

In addition to the direct effects of oil and dispersants, cleanup and containment operations also may have an effect on marine mammals. Cleanup includes containing oil in booms, skimming oil at the ocean surface, and burning. Cleanup also involves a large number of vessels and aircraft in the coastal and offshore habitats bringing increased noise levels and human presence into marine mammal habitats. These activities could stress and disturb marine mammals, potentially displacing them from important feeding or breeding grounds and disrupting normal behavior.

If a spill were to occur in the proposed project area, adverse impacts on marine mammals would range from minor to major, depending upon the size of the spill; however, such events would not be likely, particularly with BMPs already agreed to by the Applicant and listed in Section 4.3.10. Therefore, accidental spills may affect but are not likely to adversely affect marine mammals in the proposed Port footprint.

As discussed in Section 4.2.2.2, Delfin LNG would prepare a FRP that addresses the potential for petroleum-based spills from offshore pipeline construction equipment and describes preventive and response measures that would be implemented in the event of a spill. It is expected that with the FRP, immediate response actions could reduce impacts, if they occur, on marine mammal populations to temporary.

Noise

The impact of the proposed Port on non-endangered marine mammals would vary depending on species and habitat usage. Only two non-endangered marine mammal species are likely to occur in the proposed Project footprint (see Section 3.3.7 for descriptions). Marine mammals are extremely mobile, and are able to avoid most physical, chemical, or biological disturbances if detected. Although some of the proposed Project-related activities may affect marine mammals, the effects are expected to be short-term. Therefore, even if these animals do not vacate or avoid the disturbance, they are not expected to experience long-term negative or adverse effects. Given the shallow habitat of the proposed Project footprint (approximately 37.4 to 40.8 nautical miles off the coast of Cameron Parish, Louisiana, in water depths ranging from approximately 64 to 72 ft [19.5 to 21.9 m] where the shelf break in this area lies roughly 80 to 100 miles [128 to 160 km] offshore generally), only the two MMPA species of dolphin (Atlantic spotted and bottlenose) are expected to occur. The two MMPA species of dolphin that may occur are highly mobile and are able to move away from the sound source. Under the MMPA, the potential for temporary acoustic exposures from construction vessel noise would be expected (USCG 2006d,e; FERC 2006). Most proposed Project-related activities would likely be avoided by the two dolphin species in the proposed Project footprint with the exception of noise, which may ensonify most of their habitat during pile driving. For a discussion on noise impacts on marine mammals, listed and non-listed, see Section 4.3.1.1.

4.3.3.2 Impacts of Operation

The impact of the proposed Port on non-endangered marine mammals would vary depending on species and habitat usage. Only two non-endangered marine mammal species are likely to occur in the proposed Project footprint (see Section 3.3.7 for descriptions). Marine mammals are extremely mobile, and are able to avoid most physical, chemical, or biological disturbances if detected. Although some of the proposed Project-related activities may affect marine mammals, the effects are expected to be short-term. Therefore, even if these animals do not vacate or avoid the disturbance, they are not expected to experience long-term negative or adverse effects. An exception would be if a ship strike were to occur, which would be an immediate adverse impact. Most proposed Project-related activities would likely be avoided by the two dolphins in the proposed Project footprint with the exception of noise which may ensonify their habitat during DP thruster use. For a discussion on noise impacts on marine mammals, listed and non-listed, see Section 4.3.1.1.

4.3.3.3 Impacts of Decommissioning

Impacts on coastal, marine, and migratory birds would not be materially different than those previously described for construction. Short-term, minor, adverse impacts, similar to the construction impacts described in Section 4.3.3.1, would be expected from decommissioning activities.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on non-ESA-listed marine mammals would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.3.4 Coastal, Marine, and Migratory Birds

Activities associated with construction and operation of the proposed Project that would impact coastal, marine, and migratory birds include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- FLNGV and LNGC operational intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations;
- vessel and aircraft noise;
- gas flaring;
- artificial lighting;
- increased vessel traffic; and
- marine debris.

As mentioned in Section 3.3.8, more than 400 species of birds have been reported in the Northern Gulf of Mexico. Seabird ranges are variously defined using categories such as "nearshore (onshore from the coast out to 5 miles [8 km])." These birds generally occur from estuarine waters out to the shelf edge. Offshore birds generally are greater than 5 miles (8 km) off the coast, and pelagic birds are defined as occurring in waters deeper than 590 ft (180 m). The majority of northern Gulf of Mexico birds are nearshore or onshore waterbird species, many of which are also likely to be sighted nearshore though possibly offshore. Other species of seabirds that migrate can be found within the Gulf of Mexico region seasonally, or in offshore or pelagic habitats of the Gulf of Mexico. These birds would be considered transients in the area and not likely to occur with any regular frequency especially because the proposed Port footprint is not in waters of that depth.

4.3.4.1 Impacts of Construction

During Project installation, impacts on Migratory Bird Treaty Act (MBTA) coastal and marine birds would be short-term, minor, direct, adverse impacts which may occur as a result of turbidity, routine discharges, accidental releases of fuel, oil, and other chemicals, noise, increased vessel traffic, and lighting created during construction.

Benthic Habitat

No impacts are expected to birds from benthic habitat affects.

Turbidity

Short-term, minor, adverse impacts on non-ESA but MBTA-listed coastal and marine birds would result from bottom sediment disturbance activities during construction. An increase in turbidity would be associated with disturbance of soft bottom sediments. Turbidity has the potential to impact birds foraging in the water column by reducing visibility, which could potentially affect underwater movement or prey capture. These impacts would be localized, reversible, and limited to the time of construction. After construction activities cease, turbidity is expected to return to pre-trenching levels without mitigation. Duration for this post-excavation recovery may extend for days or weeks. An increase in turbidity would be localized in nature and only be conducted for a short-term during the construction phase of the proposed Project.

Routine Discharges

Routine discharges during construction are not likely to adversely affect non-ESA but MBTA-listed coastal and marine birds. The proposed Project area is not expected to contain habitat that concentrates avian activity in any one area more than any other; therefore, there is no displacement or direct harm to avifauna expected from routine discharges. If a small area was impacted by routine discharge, it is unlikely that birds would be displaced or precluded from important foraging, resting, or migrating habitat. The discharges would dissipate, and avifaunae could easily avoid unfavorable conditions. Routine discharge would not be of a magnitude that would be likely to cause harm to birds. Due to the dilution in the open ocean, these discharges would have a negligible impact on non-ESA but MBTA-listed coastal and marine birds during construction.

Accidental Releases of Fuel, Oil, and Other Chemicals

Short-term, minor, adverse impacts on non-ESA but MBTA-listed coastal and marine birds would result from inadvertent spills of petroleum products and potentially hazardous non-petroleum-based products during construction. Oil spilled on the ocean's surface would start to weather immediately. The rate of weathering would depend upon several factors, including the characteristics of the released oil and oceanographic conditions.

Noise

Noise affects birds in a variety of different ways. It can cause the temporary or permanent displacement of birds from particular areas. It can also have physical effects that are detrimental to bird health including direct trauma, hearing loss, and physiological stress (e.g., increase in heartrate and blood pressure, or changes in hormonal levels). The manner in which birds respond to noise depends on several factors, including life history characteristics (e.g., breeding or foraging) and stage (e.g., juvenile or adult) of the species, characteristics of the noise source (e.g., continuous or pulsive), sound source intensity, onset rate, distance from the noise source, presence or absence of associated visual stimuli, and previous exposure (habituation). The stressors associated with noise impacts on birds may cause behavioral changes or injury. Examples of behavioral changes include disturbance of foraging, roosting, or breeding; or degradation of foraging or nesting and breeding habitat. Increased noise and activity levels during construction and development could result in nest abandonment and decreased reproductive success if such activity occurs during the breeding season or contribute to degradation of known seabird breeding colonies. Auditory masking may occur during pile driving, i.e., masking communications by birds that are used to attract mates or defend territories.

Under the MBTA, it is illegal to "pursue, hunt, take, capture, kill, possess, offer for sale, sell, offer to barter, barter, purchase, ship, export, import, transport, or carry… any migratory bird included in the terms of the conventions between the United States and Great Britain, for the protection of migratory birds, concluded Aug. 16, 1916" (16 U.S.C. 703-712). An impact would occur if an action were to violate the terms listed above for a migratory bird.

Short-term, minor, adverse impacts on non-ESA but MBTA-listed coastal and marine birds could occur as a result of noise generated by construction machinery or construction and support vessels. Such impacts could temporarily displace birds from the area. Bird species with near or offshore coastal distribution (see Table 3.2-8) would not be impacted by noise during construction, as it is unlikely that noise generated by construction would reach coastal areas. Any displaced marine birds would be expected to return shortly after construction ceased.

Vessel Traffic

No impacts on coastal and marine birds would be expected to occur as a result of increased vessel traffic associated with routine Port operations. Traffic increases would be long-term, but minor, compared to the amount of existing vessel traffic. Support and pilot vessel operators would be required to maintain slow, wake-free speeds while navigating through sensitive inland and coastal waterways, and no physical contact with coastal and marine birds would be anticipated.

Ingestion of Marine Debris

Short-term, minor, adverse impacts on non-ESA but MBTA-listed coastal and marine birds would result from marine debris during construction. However, Impacts on coastal, marine, and migratory birds would be mitigated through adherence to existing statutes that regulate marine debris. Further, as a standard operating procedure, all vessels associated with the proposed Project would be prohibited from dumping trash of any kind. Solid waste management training would be provided that emphasizes the importance of minimizing impacts on marine species. This combination of proposed Project policy and existing regulations would ensure that any marine debris accidentally expended within the proposed Project area would be negligible.

Entanglement

No impacts are expected to birds from entanglement effects.

Lighting

Lighting has been shown to be a concern for trans-Gulf of Mexico migratory birds because they can be drawn to the light and become disoriented in the glare or may circle in confusion, colliding with infrastructure, or falling from the sky due to exhaustion (BOEMRE 2011). Many neotropical birds migrate from Mexico to North American by crossing the Gulf of Mexico nonstop over 575 miles (500 nautical miles; 925.4 km) of open water in the spring (and the reverse in autumn). The proposed Port would be located in the heart of this migratory pathway; thus, many of these trans-Gulf of Mexico migrants may encounter the proposed terminal. These birds are known to be attracted to artificial lighting on offshore facilities, and artificial light can seriously disrupt birds' migration patterns. Studies have shown that hundreds of thousands of birds die from oil and gas platform lighting effects in the Gulf of Mexico every year. A mitigation measure that has been used is alternative lights using specific wavelengths. Delfin LNG proposes to take all measures possible to minimize the amount of total lighting used on the proposed terminal to that required for safety. Additionally, the amount of light should be minimized during the height of the trans-migratory period. To reduce the disruptive effects of lighting, all lighting at the terminal should be downshielded to keep the dispersion of light to a minimum. The shields would prevent the lights from shining skyward, instead directing the light to shine only on work areas.

Shielded lighting has resulted in reductions in bird mortality (Evans Ogden 2002; Orr et al. 2013). A heliport is proposed for the FLNGVs; Delfin LNG would install lighting on the heliport in accordance with USFWS and FAA guidelines for aviation safety lights including Advisory Circular 70/7460-1L. These guidelines specify that only white or red strobe lights should be used at night and that these strobes should be minimal in number, intensity, and number of flashes.

4.3.4.2 Impacts of Operation

Impacts on non-ESA-listed but MBTA birds from Project operation would be similar to those listed above for ESA-listed birds and would be short-term, minor, direct, and adverse as a result of turbidity, routine discharges, accidental releases of fuel, oil, and other chemicals, noise, gas flaring, increased vessel traffic, and lighting created during operations.

4.3.4.3 Impacts of Decommissioning

Impacts on coastal, marine, and migratory birds would not be materially different than those previously described for construction. Short-term, minor, adverse impacts, similar to the construction impacts described in Section 4.2.6.1, would be expected from decommissioning activities.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on non-ESA-listed but MBTA birds would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.3.5 Marine Vegetative Communities

Activities associated with construction and operation of the proposed Project that would impact marine vegetative communities (i.e., *Sargassum* mats) include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- water intake associated with FLNGV commissioning;
- increased vessel traffic; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

4.3.5.1 Impacts of Construction

None of the routine construction activities would cause population-level effects; however, short-term impacts would be expected as described in the following subsections. Proposed Project construction activities would not destroy or adversely modify *Sargassum* critical habitat for the loggerhead sea turtle.

Construction Support Vessel Intake and Discharges

Short-term, minor, adverse impacts on marine vegetative communities would result from discharge from construction support vessels and direct contact with moving vessels. Water use during construction is discussed in Section 4.2.1. An irreversible impact from entrainment of organisms within the surface seawater used by construction vessels would result in direct impacts on plankton communities (see Section 4.3.7). Small invertebrates and fish living in the *Sargassum* mats may be injured or killed by the action of the propeller. However, it is also possible that *Sargassum* mats would be pushed away from the oncoming vessel due to the pressure of the bow wave and the buoyant nature of the mats.

Hydrostatic Test Water Discharge

Short-term, minor, adverse impacts on marine vegetative communities would result from hydrostatic testing discharges during construction.

Hydrostatic testing of the former UTOS pipeline would require approximately 10.5 Mgal of water. The water would be withdrawn from the Gulf of Mexico at WC 167. The HIOS line would need to be flooded with water withdrawn from the Gulf of Mexico at HI A264. Approximately 22.6 Mgal would be needed to fill the HIOS pipeline; another 0.9 Mgal would be needed for hydrostatic testing of all laterals. After the hydrostatic testing of the former UTOS pipeline, the proposed WC 167 bypass and the laterals to the FLNGVs would be installed. The UTOS and HIOS fill water would be tested for hydrocarbons and other contaminants. If needed to meet water quality requirements, the water would be filtered and treated prior to discharge. After testing and any needed filtration and treating, the water would be discharged into the Gulf of Mexico at HI A264. The total water volume discharged from the UTOS and HIOS pipelines and the four laterals would be approximately 34.0 Mgal.

A one-time irreversible impact from discharge of approximately 34.0 Mgal of surface seawater used during flushing and hydrostatic testing of the proposed pipeline would result in direct impacts on marine vegetative communities. A low-toxicity biocide and corrosive inhibitor would be used to inhibit biofouling and corrosion. Hydrostatic test water discharges would occur over a limited time frame and, with appropriate pre-discharge treatment (neutralization with hydrogen peroxide), such discharges are expected to result in short-term and minor impacts on water quality (see Section 4.2.1). Short-term, minor, adverse impacts on marine vegetative communities would result from hydrostatic testing discharges during construction. Discharges would comply with provisions of a NPDES permit.

FLNGV Commissioning

Short-term, minor, adverse impacts on marine vegetative communities would result from discharge from initial FLNGV commissioning. Once the FLNGVs have been fully commissioned, no discharges are anticipated from the vessels during operations at the proposed Port. Changes in water temperature, described in Section 4.2.1, would be confined to the area immediately adjacent to the FLNGVs. Warmed seawater discharges would have the potential to impact *Sargassum* and associated communities if located near a discharge point. Because the plume would be narrow and dissipate rapidly, adverse impacts on marine vegetative communities would be short-term and negligible.

Routine Discharges

Short-term, minor, adverse impacts on marine vegetative communities would result from routine discharges during construction. Warmed seawater discharges from engine cooling and treated domestic sanitary wastewater from construction and support vessels would have the potential to impact *Sargassum* and associated communities if located near a discharge point.

Accidental Releases of Fuel, Oil, and Other Chemicals

Accidental releases of substances, such as fuel, oil, and other chemicals stored and/or in use in support of construction, could affect water quality with potential adverse, short-term, negative impacts on species within marine vegetative communities. As discussed in Sections 4.2.2.1 and 4.2.2.2, an SPCC Plan and FRP would be implemented to handle emergency situations to ensure that any accidental spills would be small and contained, not entering the sea. A large chemical spill (greater than or equal to fifty barrels) could potentially affect marine vegetative communities, which could cause direct mortality. However, the patchy distribution of *Sargassum* mats are ubiquitous across the northern Gulf of Mexico, carried long distances by the Loop currents. Even a large spill would not have population-level impacts on any species of lower trophic-level organism. Impacts of accidental releases on marine vegetative communities would be negligible.

Vessel Traffic

Short-term, minor, adverse impacts on marine vegetative communities would result from increased vessel traffic during construction. *Sargassum* may periodically be in the pathway of support vessels during proposed Project construction. In these instances, *Sargassum* mats may be submerged to depths under the vessel and portions of the mat may be destroyed by passage under the propeller. Small invertebrates and fish living in the *Sargassum* mats may be injured or killed by the action of the propeller. However, it is also possible that *Sargassum* mats would be pushed away from the oncoming vessel due to the pressure of the bow wave and the buoyant nature of the mats.

4.3.5.2 Impacts of Operation

None of the routine operating activities would cause population-level effects; however, short- and long-term impacts would be expected as described in the following subsections. Proposed Project operational activities would not destroy or adversely modify *Sargassum* critical habitat for the loggerhead sea turtle.

Routine Discharges

The routine vessel discharges during the proposed Port operation would not adversely impact marine vegetative communities, as described above for the construction phase. Routine discharges would include deck runoff from the FLNGVs, support vessels, and LNGCs. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from the vessels would comply with USCG requirements and NPDES permits. From the RO plume, *Sargassum* mats may locally be exposed to higher salinity regimes in the areas of the FLNGVs. Seagrasses were found to be negatively affected at salinities of 38 to 39 ppth (Jenkins et al. 2012). In some cases, increases in salinity of 1 to 2 ppth have been shown to affect biota within influence of the brine discharge (Jenkins et al. 2012). However, the water depths at the proposed Port would allow for mixing within the water column and for dilution of the brine discharge plume within 328 ft (100 m) from release (see Section 4.2.3.10 and Appendix N). Similarly, for essential generator cooling water discharges, given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). Therefore, the impacts associated with continuous brine discharge and intermittent temperature discharge are considered long-term and represent a moderate adverse impact on marine vegetative communities, but would be localized to within a small area around the discharge point (within 328 ft [100 m] from the discharge source). All discharges would be permitted under the USEPA's NPDES permit.

Accidental Releases of Fuel, Oil, and Other Chemicals

Accidental releases of fuel, oil, and other chemicals stored and/or in use in support of proposed Port operations could affect water quality with potential adverse, short-term, negative impact on marine vegetative communities. As discussed in Sections 4.2.2.1 and 4.2.2.2, a SPCC Plan and FRP would be implemented to handle emergency situations to ensure that any accidental spills would be small and contained, not entering the sea. Impacts would be expected to be similar to those associated with an accidental spill during construction, as discussed above.

LNG Spills

Short-term, minor, direct adverse impacts on marine vegetative communities could occur in the unlikely event of an LNG spill. The FLNGVs are designed with features to minimize the potential for LNG spills (see Section 2.2.6). However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in frostbite or death and asphyxiation by natural gas vapors above the surface of the water. These impacts would likely occur in the immediate vicinity of the spill location; the time frame of the impact is limited (see Section 2.2.6). Since LNG would boil off as natural gas at the surface, depth and pressure required for gas to dissolve (Artemov et al. 2005) in surface waters would not be sufficient and gas vapors would disperse. In addition, the time frame for these impacts would be limited, and adverse toxic impacts would be expected to be minor after the LNG boiled off and the vapors dispersed.

The potential for a release of natural gas from the proposed Port is remote. If there were a subsea release of natural gas, the gas would rise to the water surface rapidly and dissipate. In general, whether a release is sudden or extended, physics dictate that any methane would gradually dissolve into the water column during the lifetime of the bubble as described by Fick's law, taking into account Henry's law of constants, partial pressure, and concentrations of dissolved gases (Artemov et al. 2005). Once a gas bubble reaches the surface, it would rise (being lighter than air) and be dispersed by air currents. Impacts on marine vegetative communities from such a release would be short-term and minor.

4.3.5.3 Impacts of Decommissioning on Marine Vegetative Communities

None of the routine decommissioning activities would cause population-level effects; however, short-term impacts would be expected as described in the following subsections. Proposed Project decommissioning activities would not destroy or adversely modify *Sargassum* critical habitat for the loggerhead sea turtle.

Vessel Intake and Discharges

Short-term, minor, adverse impacts on marine vegetative communities would result from intake and discharge from vessels used during decommissioning, similar to impacts described above for construction and operations. Decommissioning would be restricted to the TYMS and FLNGV area only; no pipelines would be removed.

Routine Discharges

As discussed above for construction and operations, routine vessel discharges are permitted under NPDES and not expected to cause adverse impacts on marine vegetative communities. Impacts of routine discharges on marine vegetative communities would be negligible.

Accidental Releases of Fuel, Oil, and Other Chemicals

Impacts of accidental spills on marine vegetative communities are expected to be similar to those associated with an accidental spill during construction, as discussed above. Impacts of accidental chemical spills on marine vegetative communities would be short-term and minor.

4.3.6 Benthic Resources

Activities associated with construction and operation of the proposed Project that would impact benthic resources include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- anchoring;
- periodic pipeline maintenance; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

4.3.6.1 Impacts of Construction on Benthic Resources

Pipeline Construction

Construction of the proposed Port pipelines would have minor, short-term, direct adverse impacts on benthic habitat in the immediate area. Pipeline installation for the proposed bypass at WC 167 and the four laterals would result in bottom disturbance by direct contact of anchors and pipelines. Local seafloor sediments also would be disturbed by the installation of the TYMS, four pipeline laterals, and the WC 167 bypass. Anchor setting would include testing of the anchor components under load and the final setting of the anchors, and may result in seafloor sediment disturbance of approximately 0.273 acre (0.11 ha) of soft sediments. This disturbance typically would be only during construction; however, the mooring structures, manifolds, risers, and other various apparatus associated with the TYMS would permanently cover approximately 0.15 acre (0.06 ha).

An additional 1 to 2 acres (0.4 to 0.8 ha) of benthic habitat could be impacted by other substrate-disturbing activities such as mooring construction, tie-in pits, and anchoring activities. As described in Delfin LNG's Construction Vessel Anchoring Plan, the lay barge that would be used to install the pipelines maintains position with an 8-point mooring line system (see Appendix O). The anchors would be set and then retrieved and reset in a new location as the lay barge installs each section of pipeline. Temporary anchoring by the lay barge and DSV would directly impact 8,880 acres of soft bottom substrate. Benthic organisms in the immediate anchoring location, including along the drag line, could be displaced, injured, or killed by the direct impact of the anchor or sediment during placement or retrieval of the anchor.

Complete recovery of this area to an equilibrium stage community (Stage III[25]) would be unlikely considering the existing impacts from low DO levels that fluctuate through the area due to the shifting boundary of the Dead Zone. Recovery of intermediate successional communities (Stage I and II[26]) that are characteristic of the proposed Project area (Shivarudrappa 2015) would likely be interrupted by low DO conditions over time. Benthic community recovery rates for a given project are difficult to predict, but data from related studies can provide information on a likely time frame for recovery. In the Gulf of Mexico, Brooks et al. (2006) found that re-colonization ranged from three months to 2.5 years. Seven years after experimental plowing of deep-sea sediments, Borowski (2001) reported similar infaunal abundances at impacted and unimpacted areas. Diversity (total infauna and polychaetes only) was still somewhat diminished at the impact site, and community heterogeneity was greater in the disturbed area than in the reference areas.

Table 4.3-10 shows results of studies tracking the recovery of late-stage benthic communities. Recovery to Stage III community took from several months to 7 or more years, depending on the nature of the disturbance and the baseline characteristics of the habitat.

Table 4.3-10. Summary of Studies Documenting Recovery of Soft Substrate Benthos to Equilibrium (Stage III) Community

Study	Location	Stressor	Time to Recovery
Rosenberg 1972	Sweden	Paper mill (sulfite)	3 years
Rosenberg 1976	Sweden	Enrichment	5 years
Germano et al. 1994	Coastal New England	Dredged material disposal	6 months to 1 year
Murray and Saffert 1999	Western Long Island Sound	Dredged material disposal	1 to 4 months
Massachusetts Water Resources Authority 2004	Massachusetts Bay	Storms	1 to 2 years
Rhoades et al. 1978	Long Island Sound	Dredged material disposal	1 to 2 years
Rhoades et al. 1978	Long Island Sound	Azoic sediments	6 to 8 months
Borowski 2001	Peru Basin	Experimental deep-sea plowing	Less than 7 years for infaunal abundance
Lewis et al. 2002, 2003	Shallow bay in Ireland	Pipeline construction	1 year for certain species; longer for others

[25] Stage III benthic communities are characterized by infaunal species, generally found in seafloor areas with low disturbance, and typically larger-bodied organisms that feed in a head-down position deep in the sediment, which creates distinctive subsurface pockets or "feeding voids." Such bioturbation of the sediments enhances oxygen penetration.

[26] Stage I benthic communities are characterized by infaunal species typical of newly available seafloor, from disturbance or change in environmental conditions, such as polychaete worms and amphipods. Stage II, a more intermediate phase, is characterized by larger polychaete species, bivalves and burrowing echinoderms.

Table 4.3-10. Summary of Studies Documenting Recovery of Soft Substrate Benthos to Equilibrium (Stage III) Community (continued)

Study	Location	Stressor	Time to Recovery
Byrnes et al. 2004	New Jersey and Southern New York	Sand borrow	1 to 3 years
SAIC 2004	Long Island Sound	Dredged material disposal	Less than or equal to 5 years
TRC and Battelle 2005	Massachusetts Bay	Hubline Pipeline Installation	Months to years
Brooks et al. 2006	U.S. East Coast and Gulf of Mexico	Sand dredge/mining activities	3 months to 2.5 years
Lundquist et al. 2010	New Zealand	Modeled natural and anthropogenic disturbance simulations	1 to 3 years

Recolonization of benthic organisms can be affected by many physical and biological factors. The texture of the disturbed sediment is one factor that can impact recolonization. If a change in sediment texture occurs, a change in the benthic community could occur. Additionally, overturned, deeper sediments may be hypoxic, resulting in longer periods of recolonization.

Given the dynamic nature of sediment processes in the proposed Project area, the proposed Project pipelines would be expected to create only short-term alterations to the seafloor habitat limited in spatial extent to the area where pipelines were installed. The benthic community associated with the fine and coarse sand seafloor would be expected to rapidly recover following construction (Brooks et al. 2006). Typically, following this type of disturbance, a diverse benthic infaunal community would be recolonized from organisms associated with substrate adjacent to disturbed areas within a matter of one to three years (Byrnes et al. 2004; Lundquist et al. 2010).

It is unlikely that benthic resources would experience indirect impacts from construction. Hydrostatic testing is unlikely to affect benthic communities because withdrawal and discharge of water for hydrostatic testing would use surface waters, and water use is not likely to remove a large quantity of larvae belonging to benthic species. Suspended sediment plumes resulting from construction would be short-term and limited in spatial extent.

Installation of the proposed Project pipelines would cause bottom disturbance and reduce marine environment surface area; however, because recolonization would be expected to proceed over a period of months to several years, and because the area disturbed would be small relative to comparable benthic substrate in the region, this impact would be short-term and minimal. Considering the cumulative 5 miles (8 km or 26,300 ft) of pipeline trenching, and conservatively predicting a 100-ft corridor that could be affected over a short time period by deposition to some degree under the "worst-case" scenario, approximately 61 acres (24.7 ha) of benthic habitat could be temporarily affected by pipeline installation. Benthic organisms that were not able to move out of the depositional area would be covered with sediment and suffer injury or mortality.

A discussion of sediment suspension and increases in turbidity is included in Section 4.2.2. Although turbidity would increase as a result of the resuspension of sediments (and often causes fish to disperse from areas), the impact on benthic resources would be short-term and minor. The potential for impacts would be minimized by utilizing construction techniques and BMPs designed to reduce effects. No live-bottom, reefs, or other special marine resources are located near the proposed Port site. Furthermore, localized short-term turbidity events are common in the relatively shallow waters of the proposed Project area due to frequent tropical storms and wind-driven water movements. Benthic organisms are well-adapted to fluxes in turbidity fluxes; therefore, impacts on these benthic resources from turbidity associated with pipeline installation placement are expected to be negligible. Trenches are assumed to impact a 25-ft width along the centerline. Habitat disturbances from pipeline construction would not extend beyond the 25-ft width of the pipeline corridor. Impacts from trenching and backfilling would be minor and short-term; although organisms in the immediate area would be displaced, injured, or killed, recolonization by similar benthic organisms is expected to occur within months to a few years.

Mooring Structure Installation

The proposed Port includes the emplacement of four TYMS with the attached FLNGVs and their associated service vessel moorings. Temporary increased turbidity and sediment displacement would occur during the installation of the TYMS. Piling and anchor installation would be the primary components that would affect the marine environment. When installing these components, there would be permanent bottom displacement from the creation of 0.15 acre (0.06 ha) of hard-bottom habitat in an area where hard-bottom habitat is limited; however, the displaced area would be relatively small, and the proposed Port structures would provide surface area for hard-bottom encrusting organisms to colonize. Impacts as a result of TYMS installation such as resuspension of bottom sediments would be short-term and negligible. Impacts of TYMS placement would be negligible and short-term due to the rapid and efficient nature of the construction methods used. No disturbances from construction or installation would be expected to extend beyond the permanent footprint of the proposed Port.

Small Fuel Spills during Construction

Spills from construction vessels pose a localized risk to water quality, as described in Section 4.2.1. A small fuel spill is the most likely type of spill to occur during construction, based on the history of energy-related infrastructure construction in the Gulf of Mexico (BOEM 2012a). Most small spills result from a ruptured hose during fuel transfer on service vessels and release no more than 3 barrels of diesel into the water (MMS 2007). Spills of less than 1,000 barrels are not expected to persist long enough to reach the shoreline, but may cause temporary effects to offshore resources (BOEM 2011b). Impacts of a small spill on benthic resources are extremely unlikely. Diesel spills are particularly short-lived because diesel floats on the sea surface, where its low molecular-weight constituents readily volatilize (NRC 2003b; NOAA 2006).

Soft-bottom Community

In a comprehensive analysis of impacts of energy infrastructure similar to the proposed Project, BOEM (2012a) concluded that bottom disturbance from structure emplacement operations associated with oil and gas infrastructure in the western Gulf of Mexico would produce localized, temporary increases in suspended sediment loading and decreased water clarity, but little reintroduction of pollutants.

Although localized impacts on comparatively small areas of the soft-bottom benthic habitats would occur during construction, the area of seafloor affected is miniscule compared with the surrounding acreage of similar soft-bottom habitat. BOEM concluded that installation of numerous oil and gas platforms in the northern Gulf of Mexico would not adversely impact the soft-bottom environment because each local area of impact is isolated from the next nearest area of impact by ubiquitous soft-bottom habitat throughout the GOM (BOEM 2012a). The disturbed area of soft-bottom sediments would be recolonized by larvae recruited from the overlying water or adjacent areas, but recovery may take several years (Hughes et al. 2010). Impacts to benthic habitats from the proposed Port are similar in nature but smaller in scale than those evaluated in the BOEM EIS (BOEM 2012a and references within). The proposed construction is similar in size and nature to the infrastructure evaluated by BOEM (2012a); therefore, the conclusions are considered applicable to the proposed Project. In this context, construction of the proposed Port would have only minor, short-term, localized impacts on benthic habitats.

Hard-bottom Community (Mollusks and Crustaceans)

A small number of individual shelled invertebrates may be lost within the footprint of the anchors during construction. However, almost immediately after the TYMS is installed and the FLNGVs are moored, these components of the proposed Port would begin functioning as an artificial reef. Overall, large invertebrates would benefit from the addition of hard-bottom topographic features in the area. After just a few years, many of the fish species present would be residents and not new transients (BOEM 2012a). Reef-building corals and other encrusting species are known to colonize newly introduced hard structures in the northern Gulf of Mexico (Sammarco et al. 2004). Maintenance activities have the potential to remove and/or disturb a portion of these newly created hard-bottom topographic features limited to the location and extent of the maintenance activity.

4.3.6.2 Impacts of Operation on Benthic Resources

Scour and Turbidity

Potential impacts of operation of the proposed Port on soft-bottom habitats include scour and increased local turbidity. Scour, or the removal of granular bed material by hydrodynamic forces, could occur when the hydrodynamic bottom shear stresses are greater than the sediment critical shear stress. Scour can cause changes in local turbidity concentrations and result in sediment disruption and movement due to changing tides and currents. Current forces in the Gulf of Mexico near the site would determine the level of the scour effect. Generally, the relatively slow tidal/current speeds and soft-bottom sediments in the northern Gulf of Mexico suggest that scour would be minimal around the weathervaning TYMS. Tropical storms and hurricanes would likely increase the amount of scour temporarily, and result in increased localized turbidity. Turbidity would be minor, short-term, and localized; however, impacts from scour would occur throughout operation of the proposed Port due to port structures and would be minor and localized. Scour impacts would persist during the operational period of the proposed project and several months to years following removal of the TYMS. However, recolonization by benthic organisms could eventually restore the soft-bottom habitat to a more typical pre-impacted condition.

Small-scale temporary turbidity events are common in the northern Gulf of Mexico, where tropical storms and hurricanes roil the nearshore waters. Benthic resources in the proposed Project area are well-adapted to these somewhat turbulent conditions, and would not experience any lasting harm from transient turbidity fluxes. No turbidity-sensitive benthic habitats (such as seagrass beds, oyster reefs, and topographic live-bottom features) occur in the vicinity of the proposed Port (BOEM 2012a). Newly settled organisms on proposed Project structures would be subject to impacts due to the same naturally occurring small-scale temporary turbidity events.

Routine Discharges

Due to the higher density of the RO plume, sinking may locally expose pelagic and benthic organisms to higher salinity regimes in the areas of the FLNGVs. Seagrasses were found to be negatively affected at salinities of 38 to 39 ppth (Jenkins et al. 2012). In some cases, increases in salinity of 1 to 2 ppth have been shown to affect biota within influence of the brine discharge (Jenkins et al. 2012). However, the water depths at the proposed Port would allow for mixing within the water column and for dilution of the brine discharge plume within 328 ft (100 m) from release, long before reaching the ocean bottom (see Section 4.2.3.10 and Appendix N). Similarly, for essential generator cooling water discharges, given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). More mobile, pelagic species such as fish would be able to avoid the discharge plumes within the water column during mixing of the plume within the water column. Therefore, the impacts associated with continuous brine discharge and intermittent temperature discharge are considered long-term and represent a moderate adverse impact on marine vegetative communities, but would be localized to within a small area around the discharge point (within 328 ft [100 m] from the discharge source). All discharges would be permitted under the USEPA's NPDES permit.

Nonindigenous Species

Most oceangoing vessels carry marine organisms within their ballast tanks and encrusted on their hulls. However, ballast water discharge is regulated by the USCG under the National Invasive Species Act and related statues; LNGCs are not unique in carrying nonindigenous organisms. LNGCs would be required to meet CFR Title 46, Chapter I, Subchapter Q, Part 162 that addresses requirements for BWMS to be installed onboard vessels for the purpose of complying with the ballast water discharge standard of 33 CFR part 151, subparts C and D.

Compliance with USCG and international regulations on ballast water treatment and discharge would minimize the potential for introduction of nonindigenous organisms in ballast water discharge to the proposed Project area. The release of nonindigenous organisms in ballast water from LNGCs would have negligible impacts on benthic resources because LNGCs would comply with Federal ballast water treatment regulations that apply to all oceangoing vessels.

Nonindigenous species encrusted on or attached to the hulls, anchors, and other external portions of LNGCs could be released to the Gulf of Mexico. However, unintentional transport of encrusting organisms is a feature of all marine vessels. LNGCs would not pose a greater risk of transporting encrusting organisms than other similar vessels. Impacts of nonindigenous organisms transported by LNGCs on benthic resources would be negligible.

Chemical Spills during Operation

The proposed Port would have negligible impacts on benthic resources due to chemical spills during operation. Impacts to marine habitats can occur if a spill of hazardous substances results in migration and direct impact on the resource, or if the spilled substance results in the degradation of water quality near the resource. Hazardous materials would be stored and managed in compliance with applicable regulations. Further, the proposed Project would not include refueling capabilities for support vessels or supplies for provisioning those vessels. Limited fuel (such as diesel) would be stored on the FLNGV for use during startup and for emergency provisioning of support vessels and helicopters.

For the proposed Project, any spills that would occur during construction would have a high probability for being considered small or minor. The size of the spill is important, but the spilled material is just as important. The following provides summaries of fate, effects and likely environmental impacts from various petroleum products that could be spilled during project activities. Based on this stipulation, and the fact that large quantities of petroleum hydrocarbons or other hazardous waste would be stored to prevent a release, the risk potential from a spill is very low.

Marine Diesel Fuel

Marine diesel fuel is considered a non-persistent oil (as compared to a heavier bunker or crude oil product) in even the most calm sea conditions, as it will lose 40 percent of its volume due to evaporation within 48 hours in the Gulf of Mexico. Adverse weather will disperse the sheen into smaller slicks, creating a greater surface area for evaporation. In open rough seas, most of the volume released will be dispersed and evaporated within 5 days. Nevertheless, marine diesel fuel still poses a threat to marine organisms and particularly birds if they happen to come into contact with the slick.

Marine Diesel Fuel in Sediments: In general, marine diesel fuel can penetrate sediment since its viscosity is so low. The extent of penetration depends on the sediment type. As is found in the proposed Project area, in porous sediment such as sand, it can penetrate quickly and to depth. In clay-like sediment, penetration is slow. Marine diesel fuel typically evaporates before it can sink into the sediment.

Summary Properties: Marine diesel fuel has relatively rapid evaporation and dissolution rates in the water column (surface winds expedite these qualities), is not prone to form stable emulsions, has relatively high aquatic toxicity, and exhibits rapid natural degradation or remediation in water and surface sediments on the order of days to months.

Lubricating/Hydraulic Oils

Lubricating oils, for all their differences in formulation, have many similarities. When spilled into a lake, river, or ocean, they will spread rapidly to a thin slick. They will not evaporate but will disperse fairly readily in high-energy conditions without the addition of chemical dispersants. In general, lubricating oils are of low to moderate aquatic toxicity. While the base oils used in the production of lubricating oils are generally of extremely low toxicity to aquatic organisms, the large number of different additives, in varying amounts, makes it impossible to issue more specific statements, unless details of the composition (usually proprietary) are known. Lubricating oils are ubiquitous, being used in all types of engines operating on land, at sea, and in the air. Compound classes that would impart undesirable qualities to a lubricant (waxes, polar compounds, and others) are removed in the refining processes.

Bunker C

Dispersion and evaporation behaviors of marine diesel oil (MDO), Intermediate Fuel Oil (IFO) 180 and Bunker C: In recent years, the International Organization for Standardization and the American Society for Testing and Materials have published standard specifications for marine fuels. In summary, these documents set out specifications for 19 grades of marine fuels: 4 distillate fuels and 15 residual fuels. Despite the existence of such specifications, marine fuels continue to be referred to using broad categories such as MDO, IFO 180, and Bunker C. MDOs are generally formulated from middle distillates, typically containing less than 10 percent residuum. IFOs are blends of heavy residual fuels with enough distillate to lower the viscosity to that required.

Natural dispersion and evaporation behaviors of MDO, IFO 180, and Bunker C and effectiveness of chemical dispersants: MDO disperses readily in high sea states and will also evaporate up to 50 percent in two days, and completely in approximately 5 days. Chemical dispersants, although effective on MDO spills, are not recommended as natural dispersion is likely. The distillate component of IFO behaves independently of the residual component, dispersing and evaporating in the same manner as MDO. Bunker C will remain essentially unchanged even after long periods of time. Chemical dispersants are not effective with either IFO 180 or Bunker C.

Aquatic toxicity and effect on the environment of MDO, IFO 180, and Bunker C: MDO, and refined fuels in general (e.g., diesel and gasoline), have high aquatic toxicity values due to their relatively high content of naphthalenes. The aquatic toxicity of Bunker C is relatively low because it contains only small quantities of compounds that are soluble in water. The distillate component of IFO behaves independently of the residual component, with aquatic toxicity similar to that of MDO. Bunker C, on the water or along the shoreline, will remain essentially unchanged even after long periods of time.

On a regional basis, oil spills from the FLNGVs are expected to be minimal because of the small quantities stored on the vessels. No sensitive benthic resources occur in the vicinity of the proposed Port site. All Project components would be equipped with spill containment kits. Adverse impacts of chemical spills would be minor and short-term.

Physical Disturbance of Soft-bottom Habitat

As discussed above, impacts from scour would occur throughout operation of the proposed Port due to port structures. However, these impacts would be would be minor and localized, and not expected to result in any population-level impacts on soft-bottom communities. No additional impacts on the soft-bottom community are expected to result from operations.

Hard-bottom Community (Mollusks and Crustaceans)

The discussion of impacts on hard-bottom habitat described for construction is applicable to operational phase of the proposed Project. No additional impacts on the hard-bottom community are expected to result from operations.

4.3.6.3 Impacts of Decommissioning on Benthic Resources

Decommissioning would include disassembly and removal of the TYMS and the associated service vessel moorings. Pipelines would be cleaned and left in place with no intrusive activities resulting from that activity. The FLNGVs would be floated to another location. It is estimated that decommissioning would take approximately 10 weeks to complete. No explosives would be used during the decommissioning of the proposed Project.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on benthic resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

Soft-bottom Habitat Disturbance

Removal of the TYMS and FLNGVs would suspend fine sediment and increase turbidity in the immediate area. Impacts would be similar to those described for construction, but of shorter duration (5 months), as compared to construction activities.

Hard-bottom Community (Mollusks and Crustaceans)

The hard-substrate habitat provided by the TYMS (footprint of approximately 0.15 acre) is expected to become encrusted with living invertebrates, including mollusk, crustaceans, echinoderms, and corals within several months of installation. After three decades of operation, a large complex artificial reef community is expected to be in place in the underwater portions of the proposed Port. Because the proposed Project area has no substantial hard-bottom or topographic features other than the proposed Port, decommissioning and removal of the structures will result in destruction of encrusted or attached organisms and loss of the reef habitat that supported pelagic fishes, marine birds, sea turtles, and marine mammals. FLNGVs would likely be maintained to prevent hulls from fouling by settlement of encrusting organisms. Impacts of decommissioning of approximately 0.15 acre (total TYMS footprint acreage) of hard-bottom resources would be adverse, direct, long-term, and minor.

4.3.7 Plankton

Activities associated with construction and operation of the proposed Project that would impact plankton include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- water intake associated with FLNGV commissioning;
- vessel and aircraft noise;
- anchoring;
- artificial lighting;
- increased vessel traffic;
- marine debris;

- periodic pipeline maintenance; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

The tiny size, wide distribution, and overall abundance of planktonic organisms in the open Gulf of Mexico affords these species protection from small, localized impacts. Construction, operation, and decommissioning may result in entrainment of plankton or localized environmental changes to habitat (e.g., turbidity plumes or temperature increases). None of the routine construction activities would cause population-level effects.

4.3.7.1 Impacts of Construction on Plankton

Turbidity

Short-term, minor, adverse impacts on plankton would occur as a result of turbidity increases associated with the construction of the proposed Port. Indirect impacts would occur because increases in turbidity would cause a reduction in the depth of light penetration, and would have the potential to negatively impact phytoplankton productivity (Berry et al. 2003). Turbidity impacts on marine plankton could include reduced vertical migrations, reduced feeding, direct mortality and toxicity, and physiological impairment (Berry et al. 2003; Byrnes et al. 2003). Laboratory tests indicated that mysids exposed to 230 mg/L of natural sediment and copepods exposed to 1,020 mg/L of natural sediment for 28 days experienced 40 percent and 60 to 80 percent mortality, respectively (Berry et al. 2003). Impacts on zooplankton from turbidity are expected to be restricted to the lower portion of the water column (Byrnes et al. 2003).

For most of the year in the north-central Gulf of Mexico, density of ichthyoplankton is greater at the surface and decreases with depth (Shaw et al. 2002). Some larvae undergo daily vertical migrations in response to daylight (Shaw et al. 2002). Ichthyoplankton in the upper zones of the water column would be outside the range of construction-related turbidity effects.

As mentioned in Section 4.2.2.1, small-scale temporary turbidity events are common in the northern Gulf of Mexico, where tropical storms and hurricanes roil the nearshore waters. Benthic resources in the proposed Project area are well-adapted to these somewhat turbulent conditions, and would not experience any lasting harm from transient turbidity fluxes. Impacts on plankton from construction of the proposed Port would be short-term and negligible.

Construction Support Vessel Intake and Discharges

Short-term, minor, adverse impacts on plankton would result from intake and discharge from construction support vessels and direct contact with moving vessels. Water use during construction is discussed in Section 4.2.1. An irreversible impact from entrainment of organisms within the surface seawater used by construction vessels would result in direct impacts on plankton communities. Early life stages of fishes that are planktonic (passively floating or weakly swimming) in the upper zones of the open ocean could be displaced or injured by vessels or their propellers. However, the number of individuals exposed to vessel movements would be low relative to total planktonic mass in the immediate vicinity. Also, the life history of most fishes already includes an extremely high natural mortality rate from predation, such that most eggs and larvae are not expected to survive to the next life stage (Helfman et al. 2009; Horst 1977).

Hydrostatic Test Water Discharge

Short-term, minor, adverse impacts on plankton would result from hydrostatic testing intake and discharges during construction.

Hydrostatic testing of the former UTOS pipeline would require approximately 10.5 Mgal of water. The water would be withdrawn from the Gulf of Mexico at WC 167. The HIOS line would need to be flooded with water withdrawn from the Gulf of Mexico at HI A264. Approximately 22.6 Mgal would be needed to fill the HIOS pipeline; another 0.9 Mgal would be needed for hydrostatic testing of all laterals. After the hydrostatic testing of the former UTOS pipeline, the proposed WC 167 bypass and the laterals to the FLNGVs would be installed. The UTOS and HIOS fill water would be tested for hydrocarbons and other contaminants. If needed to meet water quality requirements, the water would be filtered and treated prior to discharge. After testing and any needed filtration and treating, the water would be discharged into the Gulf of Mexico at HI A264. The total water volume discharged from the UTOS and HIOS pipelines and the four laterals would be approximately 34.0 Mgal.

A one-time irreversible impact from entrainment of organisms within the approximately 34.0 Mgal of surface seawater used during flushing and hydrostatic testing of the proposed pipeline would result in direct impacts on plankton communities. Although the seawater would be screened to prevent fish from being swept into the pipeline, and filtered to remove sediment during filling, plankton would be entrained. A low-toxicity biocide and corrosive inhibitor would be used to inhibit biofouling and corrosion. Hydrostatic test water discharges would occur over a limited time frame and, with appropriate pre-discharge treatment (neutralization with hydrogen peroxide), such discharges are expected to result in short-term and minor impacts on water quality (see Section 4.2.1). Short-term, minor, adverse impacts on ichthyoplankton would result from hydrostatic testing intake and discharges during construction (see Sections 4.3.7.1 and 4.4.1.3 for impacts of construction on ichthyoplankton). Discharges would comply with provisions of a NPDES permit.

FLNGV Commissioning

Short-term, minor, adverse impacts on phytoplankton would result from water intake and discharge from initial FLNGV commissioning. Once the FLNGVs have been fully commissioned, no discharges are anticipated from the vessels during operations at the proposed Port. Changes in water temperature, described in Section 4.2.1, would be confined to the area immediately adjacent to the FLNGVs. A small number of eggs and fish larvae may be harmed. Because the plume would be narrow and dissipate rapidly, adverse impacts on plankton would be short-term and negligible.

Routine Discharges

The routine vessel discharges during construction discussed in Section 4.1 would not result in adverse impacts on planktonic species. Routine discharges from these marine vessels would include deck runoff and engine cooling water. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from the marine vessels would comply with USCG requirements. Routine discharges during construction would have negligible adverse impacts on plankton.

Accidental Releases of Fuel, Oil, and Other Chemicals

Accidental releases of substances, such as fuel, oil, and other chemicals stored and/or in use in support of construction, could affect water quality with potential adverse short-term impacts on planktonic species. As discussed in Sections 4.2.2.1 and 4.2.2.2, an SPCC Plan and FRP would be set in place to handle emergency situations to ensure that any accidental spills would be small and contained, not entering the sea. The only event that could potentially affect plankton is a large chemical spill (greater than or equal to 50 barrels), which could cause direct mortality. However, plankton are ubiquitous across the well-mixed waters of the northern Gulf of Mexico, carried long distances by the Loop currents. Even a large spill would not have population-level impacts on any species of lower trophic-level organism. Impacts of accidental releases on plankton would be negligible.

Lighting

Negligible impacts on plankton are expected to occur as a result of lighting associated with the proposed Project construction. While phytoplankton, zooplankton, and some ichthyoplankton respond to light cues, any potential for altered responses resulting from lighting used during construction would be negligible relative to the planktonic populations in the northern Gulf of Mexico.

4.3.7.2 Impacts of Operation on Plankton

Turbidity

Short-term, minor, adverse impacts on plankton would occur as a result of turbidity increases associated with the proposed Port operation in the same manner as described above for the construction phase. Routine operation activities with potential to impact turbidity are limited to the movement and possible minor bottom scouring associated with anchor chains, wire, and umbilical systems.

Entrainment

Direct, long-term, minor, adverse impacts of entrainment on plankton would occur during operation of the proposed Port. Entrainment of plankton by large capacity water intakes has historically been a concern; however, modern intake structures are designed to allow mobile plankton to escape and to limit the entrainment of smaller life forms. The proposed Port would use an air-cooled system to minimize cooling water needs. Cooling water operations would be restricted to emergency generators only, causing minimal entrainment of plankton (see Appendix I).

Each FLNGV would use approximately 3.03 Mgal of seawater per day, or approximately 12 mgd for all four FLNGVs during full operation. This represents a reduction in seawater use of over 98 percent as compared to an open loop process cooling system that might require 200 million gallons of seawater per day for each of the four FLNGVs. The 3.03 Mgal of seawater used per FLNGV each day equates to approximately 4.4 billion gallons of water per year for all four FLNGVs. In addition, as noted in Section 2.2.10, the maximum intake velocity across the sea chest screens would be less than 0.5 ft/s, further reducing the potential for entrainment impacts.

Routine Discharges

The routine vessel discharges during the proposed Port operation would not adversely impact plankton, as described above for the construction phase. Routine discharges would include deck runoff from the FLNGVs, support vessels, and LNGCs. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from the vessels would comply with USCG requirements and NPDES permits. Due to the higher density of the RO plume, sinking may locally expose pelagic and benthic organisms to higher salinity regimes in the areas of the FLNGVs. Seagrasses were found to be negatively affected at salinities of 38 to 39 ppth (Jenkins et al. 2012). In some cases, increases in salinity of 1-2 ppth have been shown to affect biota within influence of the brine discharge (Jenkins et al. 2012). However, the water depths at the proposed Port would allow for mixing within the water column and for dilution of the brine discharge plume within 328 ft (100 m) from release (see Section 4.2.3.10 and Appendix N). Similarly, for essential generator cooling water discharges, given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). More mobile, pelagic species such as fish would be able to avoid the plume within the water column during mixing of the plume within the water column. Therefore, the impacts associated with continuous brine discharge and intermittent temperature discharge are considered long-term and represent a moderate adverse impact on marine vegetative communities, but would be localized to within a small area around the discharge point (within 328 ft [100 m] from the discharge source). All discharges would be permitted under the USEPA's NPDES permit.

Accidental Releases of Fuel, Oil, and Other Chemicals

Accidental releases of fuel, oil, and other chemicals stored and/or in use in support of construction could affect water quality with potential short-term negative impact on plankton. As discussed in Sections 4.2.2.1 and 4.2.2.2, an SPCC Plan and FRP would be set in place to handle emergency situations to ensure that any accidental spills would be small and contained, not entering the sea. Impacts would be expected to be similar to those associated with an accidental spill during construction, as discussed above.

LNG Spills

Short-term, minor, direct adverse impacts on plankton could occur in the unlikely event of an LNG spill. The FLNGVs are designed with features to minimize the potential for LNG spills (see Section 2.2.6). However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in frostbite or death and asphyxiation by natural gas vapors above the surface of the water. These impacts would likely occur in the immediate vicinity of the spill location; the time frame of the impact is limited (see Section 2.2.6). Since LNG would boil off as natural gas at the surface, depth and pressure required for gas to dissolve (Artemov et al. 2005) in surface waters would not be sufficient and gas vapors would disperse. In addition, the time frame for these impacts would be limited, and adverse toxic impacts would be expected to be minor after the LNG boiled off and the vapors dispersed.

The potential for a release of natural gas from the proposed Port is remote. If there were a subsea release of natural gas, the gas would rise to the water surface rapidly and dissipate. In general, whether a release is sudden or extended, physics dictate that any methane would gradually dissolve into the water column during the lifetime of the bubble as described by Fick's law, taking into account Henry's law of constants, partial pressure, and concentrations of dissolved gases (Artemov et al. 2005). Once a gas bubble reaches the surface, it would rise (being lighter than air) and be dispersed by air currents. Plankton impacts from such a release would be short-term and minor.

Planned and Unplanned Maintenance and Repair

Beyond impacts associated with vessel transits, including intake and discharge of water, and the risk of entrainment of organisms, no adverse impacts on plankton are expected to occur during planned and unplanned maintenance and repair.

Lighting

Negligible impacts on plankton would occur as a result of lighting associated with the proposed Port operation, as described above for the construction phase. Artificial lighting associated with offshore structures is known to attract some zooplankton and larval stages of some fish (Lindquist et al. 2005; Keenan 2007). The proposed Port would require lighted aids to navigation and operational lighting for 24-hour operations with illuminated deck lights for FLNGVs; however, lighting would be minimized to the extent practicable. Impacts of lighting on plankton would be negligible.

4.3.7.3 Impacts of Decommissioning on Plankton

Turbidity

Short-term, minor, adverse impacts on plankton would occur as a result of turbidity increases associated with decommissioning. The type and magnitude of impacts on plankton are the same as described above for the construction phase.

Entrainment

Short-term, minor, adverse impacts on plankton would result from decommissioning the proposed Project. Entrainment losses of plankton during decommissioning would be short-term and negligible.

Vessel Intake and Discharges

Short-term, minor, adverse impacts on plankton would result from intake and discharge from vessels used during decommissioning, similar to impacts described above for construction and operations. Decommissioning would be restricted to the TYMS and FLNGV area only; no pipelines would be removed.

Routine Discharges

As discussed above for construction and operations, routine vessel discharges are permitted under NPDES and not expected to cause adverse impacts on plankton. Impacts of routine discharges on plankton would be negligible.

Accidental Releases of Fuel, Oil, and Other Chemicals

Impacts of accidental spills on plankton are expected to be similar to those associated with an accidental spill during construction, as discussed above. Impacts of accidental chemical spills on plankton would be short-term and minor.

Lighting

Impacts of lighting on plankton would be comparable to those described above for the construction and operation phases of the proposed Project. Impacts of lighting on plankton would be negligible.

4.3.8 Fisheries Resources

Activities associated with construction and operation of the proposed Project that would impact fisheries resources include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;
- water intake associated with FLNGV commissioning;
- vessel and aircraft noise,
- anchoring;
- artificial lighting;
- increased vessel traffic;
- marine debris;
- alteration of prey species through removal or addition of habitat;
- periodic pipeline maintenance; and
- accidental releases of LNG, fuel, oil, and other chemicals during construction and operations.

Hundreds of marine species occur in the northern Gulf of Mexico, and many of them are likely to encounter the proposed Port during some life stage. Impacts of construction, operation, and decommissioning on fishes are expected to vary among species and life stages, and in general, would be similar to impacts expected on essential fish habitat (EFH) species, as discussed in Section 4.4. Activities that affect juvenile and adult fish may differ markedly from those that affect eggs and larvae. Impacts on plankton, including ichthyoplankton, are discussed in Sections 4.3.7 and 4.4.1, as well as Appendix I. Large mobile juvenile and adult fish would actively avoid most impacts associated with the proposed Port, such as noise and vessel strikes. Eggs and larvae cannot actively avoid such stressors, but are so abundant in the proposed Project area that impacts are rarely greater than minor. Overall, a relatively small number of fish at any life stage would be affected, resulting in a negligible impact on any given species.

4.3.8.1 Impacts of Construction on Fisheries

Benthic Habitat

The impacts on benthic habitat discussed in Section 4.2.2.1 are relevant to fishes that live or forage in soft-bottom habitats. Short-term, negligible, adverse impacts on demersal fish would occur as a result of seafloor disturbance during proposed Port construction. Fish most likely to be affected by construction activities would be those that prefer soft substrate habitat in water depth where the pipeline and TYMS would be placed. The plowed installation and burial of the proposed pipeline would result in a short-term disturbance of approximately 60 acres of seafloor along the length of the proposed pipeline route (see Section 4.2.2.1). Direct and indirect impacts on marine fish would include disturbance to benthic habitats and localized increases in turbidity.

Turbidity

The discussion of the impact of turbidity on benthic habitats (Section 4.2.2.1) provides estimates of the area of seafloor where increased turbidity could occur during construction. Small-scale temporary turbidity events are common in the northern Gulf of Mexico, where tropical storms and hurricanes roil the nearshore waters. Fishes in the proposed Project area are well-adapted to these somewhat turbulent conditions, and would not experience any lasting harm from transient turbidity fluxes. No turbidity-sensitive fish habitats (such as seagrass beds, oyster reefs, and topographic live-bottom features) occur in the vicinity of the proposed Port (BOEM 2012a).

Construction Support Vessel Intake and Discharges

Short-term, negligible, adverse impacts on fishes would result from intake and discharge from vessels used during construction. Impacts would be expected to be restricted to the area immediately surrounding the construction site. Discharges would be permitted under NPDES and diluted quickly in the open water of the Gulf.

Hydrostatic Test Water Discharge

Short-term, negligible, adverse impacts on fish would result from hydrostatic testing. The use of screens, coupled with a low intake velocity, would limit the risk of impingement. Hydrostatic test water would be drawn from surrounding seawater and be discharged to the Gulf of Mexico near the proposed site. Only USEPA-approved chemicals would be introduced into the test water. Any impacts on water quality would be localized and transient, with negligible impacts on marine fish.

FLNGV Commissioning

Short-term, minor, adverse impacts on some marine fish species would result from water discharge from initial FLNGV commissioning due to thermal plumes, as described in Section 4.2.2.2 for plankton. Adult and juvenile fish would be capable of escaping an unfavorable thermal plume. Because the plume would be small and dissipate rapidly, impacts on fishes would be short-term and minor.

Routine Discharges

As discussed in Section 4.1, routine vessel discharges during the proposed Port construction would not result in adverse impacts on fish species. Routine discharges from these marine vessels would include deck runoff and engine cooling water. All gray water and sanitary wastewater would be stored onboard for appropriate disposal. All discharges from the marine vessels would comply with USCG and NPDES permit requirements. Juvenile and adult fish have sufficient mobility to evacuate or avoid unfavorable conditions. Therefore, routine discharges would have a negligible impact on fish populations.

However, the water depths at the proposed Port would allow for mixing within the water column and for dilution of the brine discharge plume within 328 ft (100 m) from release, long before reaching the ocean bottom (see Section 4.2.2.2 and Appendix N). Similarly, for essential generator cooling water discharges, given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). More mobile, pelagic species such as fish would be able to avoid the discharge plumes within the water column during mixing of the plume within the water column. Therefore, the impacts associated with continuous brine discharge and intermittent temperature discharge are considered long-term and represent a moderate adverse impact on marine vegetative communities, but would be localized to within a small area around the discharge point (within 328 ft [100 m] from the discharge source). All discharges would be permitted under the USEPA's NPDES permit.

Accidental Releases of Fuel, Oil, and Other Chemicals

The discussion of impacts of accidental chemical releases on benthic habitats and plankton above is applicable to fisheries. The only event that could potentially affect fisheries is a large chemical spill, which could cause direct mortality in the immediate area. Mobile fishes would typically leave the area, as fish are capable of detecting and avoiding chemicals in the water.

Numerous comprehensive evaluation of impacts of oil and gas exploration and development, which includes activities comparable to the ones proposed for the proposed Port, concluded that small fuel or chemical spills (less than or equal to 1 barrel) would not affect fishes in the offshore environments of the Gulf of Mexico (MMS 2007, 2008; BOEM 2011b, 2012b). The Proposed Action does not include any unique activities that would change the conclusions of the regional EISs.

Noise

Short-term, minor, adverse impacts on fish would result from noise generated during the proposed Port construction. The construction and support vessels would generate sounds that could be perceived by marine fishes. All fish have two sensory systems that are used to detect sound in the water: the inner ear, which functions very much like the inner ear found in other vertebrates, and the lateral line, which consists of a series of receptors along the body of the fish (Popper 2008). The inner ear generally detects higher frequency sounds while the lateral line detects water motion at low frequencies (below a few hundred Hz). It is difficult to discern the impacts of sound alone because vessels tend to produce sound and movement at the same time.

The physiological responses of marine fishes to vessel movements (Brown and Murphy 2010) and underwater noise (Popper 2003; Codarin et al. 2009; Slabbekoorn et al. 2010; Wright et al. 2010) have been investigated for only a limited number of marine fishes (Popper and Hastings 2009a,b). Underwater sounds such as engine noise generated from all vessel types have been demonstrated to elicit various responses in such fishes as Pacific herring (*Clupea pallasii*), Atlantic cod (*Gadus morhua*), haddock (*Melanogrammus aeglefinus*), and sea bass, as described by Buscaino et al. (2010), Popper (2003), and Popper and Hastings (2009a,b). The physiological structure of hearing in fishes results in different responses to underwater human-made sounds, compared with marine mammals (Popper et al. 2007); in most cases, human-made sound is not expected to affect marine fishes at all (Kane et al. 2010). It is possible that some fish would leave the construction area temporarily because of in-water disturbances, and the distance between the fish and the noise source would increase, thereby minimizing the chance of injury. Avoidance of a sound source would ultimately reduce exposure, particularly at the highest sound pressure levels and/or distances closest to the source.

With no mitigation measures employed, physical injury (all types) to marine fauna could potentially occur within both the SPL (see Figure 4.3-1) and SEL ZOIs (see Figure 4.4-1). A small number of studies investigating the possible effects of noise, primarily seismic sound, on fish behavior have been conducted over the years. Studies looking at change in distribution are often conducted at larger spatial and temporal scales than are typical for studies that examine specific behaviors, such as startle response, alarm response, and avoidance response. The studies that examine those specific defined responses often involve caged fish rather than free-ranging fish (Hirst and Rodhouse 2000). Masking of natural/ambient sounds (e.g., communication, detection of predators and prey, gleaning of information about the surrounding environment) also has the potential to affect fish behavior.

Pile-driving activities at each mooring platform would only occur for approximately one week. It is highly probable that some fish would avoid the area because of disturbing levels of sound when the impact hammer is operating; noise levels exceeding an assumed background level of up to 150 dB re 1 μPa rms can cause fish to avoid the immediate area around a pile being driven. However, because of the short time frame for pile placement, it is predicted that no fish would be permanently deterred from the area for foraging. In addition, because the area of disturbance would be small and similar habitat surrounds the site, any avoidance activity would not require extra energy expenditures. It would be expected that some acoustic disturbance of fish close to an individual pile being driven, or within the immediate Project area, could occur, but these impacts would be short-term and negligible and would not be expected to result in population-level effects. Therefore, short-term, minor, adverse impacts on fishes would result from noise associated with pile driving during construction.

See Section 4.4.1.5 for effects of construction noise on fish.

Vessel Traffic

Short-term, negligible, adverse impacts on marine fish would occur as a result of construction vessel traffic during proposed Port construction. Studies documenting behavioral responses of fishes to vessels show that most adults exhibit avoidance responses to engine noise, sonar, depth finders, and fish finders (Jørgensen et al. 2004), reducing the potential for vessel strikes. Misund (1997) found that fish ahead of a ship that showed avoidance reactions did so at ranges of 160–490 ft (50–350 m). When the vessel passed over them, some fish responded with sudden escape responses that included lateral avoidance or downward compression of the school. Avoidance reactions are quite variable depending on the type of fish, its life history stage, behavior, time of day, and the sound propagation characteristics of the water (Schwarz 1985). The low-frequency sounds of large vessels or accelerating small vessels caused avoidance responses among herring (Chapman and Hawkins 1973), but avoidance ended within 10 seconds after the vessel departed. Twenty-five percent of the fish groups became habituated to the sound of the large vessel and 75 percent of the responsive fish groups became habituated to the sound of small boats. Some eggs, larvae, and juvenile fish may be killed or injured by contact with a ship or its propellers. Behavioral impacts would be short-term, with return to normal behavior after the ship passes.

Vessels do not normally collide with adult fish, most of which have the ability to detect and avoid oncoming vessels. However, it is feasible that a vessel could collide with a fish under unusual circumstances, such as when dense groups of spawning fishes occur in open water. An exception to the general pattern of fishes avoiding vessel collisions is the whale shark, which is vulnerable to ship strikes. Numerous collisions with whale sharks have been recorded worldwide, although the number and size of shipping vessels in the modern cargo fleets make it difficult to gather death data as personnel on large ships are often unaware of whale shark collisions (Stevens 2007). The results of a whale shark study outside of the study area in the Gulf of Tadjoura, Djibouti, revealed that of the 23 whale sharks observed over 5 days, 65 percent had scarring from boat and propeller strikes (Rowat et al. 2007).

Any impacts of vessel movements on adult or larval fishes would be negligible because of the following factors:

- the infrequent visits of relatively slow-moving LNGCs;
- the ability of most fish to detect vessel movements;
- most adult fishes being generally capable of active avoidance, making strikes rare and allowing the fish to return to normal behavior after the ship or device passes;
- the small number of slow-moving species near the water surface, such as whale sharks, compared to larger number of fast swimming species near the surface, such as tuna; and

- the low number of individuals exposed to vessel movements, relative to total planktonic mass in the study area.

Ingestion of Marine Debris

Short-term, negligible, adverse impacts on marine fish would result from the accidental release of marine debris (e.g., ropes, plastic) during construction. Marine debris of a size that can be swallowed by a fish could be eaten either at the surface, in the water column, or at the seafloor; therefore, all six trophic guilds may be impacted. Open-ocean planktivores and piscivores are most likely to ingest materials in the water column, though. Coastal bottom-dwelling predators and estuarine bottom-dwelling predators, such as crab-eaters and benthivores, could ingest materials from the seafloor. The potential for fish to encounter and ingest marine debris depends on their feeding group, size, and geographic range. While no aspect of the proposed action includes the intentional “dumping” of debris in the marine environment, it is possible that during routine construction activities some construction-related debris could end up as marine debris.

Delfin LNG’s standard operating procedures for minimizing marine debris are aligned with MARPOL 73/78 Annex V requirements and Federal regulations. Construction workers may not purposefully discard trash or debris overboard into the marine environment. To discourage illegal dumping, Federal regulations require that all equipment, tools, and containers (such as drums) be marked with permanent identification (30 CFR 250.300(c)). As required by USEPA and USCG, Delfin LNG would prepare a waste management plan and require construction workers to follow it. Best practices such as covering trash bins, sending ashore, and minimizing solid waste in general, would reduce impacts of marine debris on fisheries to negligible levels.

Entanglement

Negligible impacts on marine fish would occur from entanglements in anchor lines, tethers, or other materials during construction. Unlike typical fishing nets and lines, the equipment used during construction would not be designed for trapping or entanglement purposes. An item capable of entangling a fish (e.g., rope, plastic) could inadvertently fall into the water from the deck of a construction vessel. Most fish entanglement observations involve abandoned or discarded nets, lines, and other materials that form loops or incorporate rings (Derraik 2002; Keller et al. 2010; Laist 1987; Macfadyen et al. 2009). A 25-year dataset assembled by the Ocean Conservancy reported that fishing line, rope, and fishing nets accounted for 68 percent of fish entanglements, with the remainder due to encounters with various items such as bottles, cans, and plastic bags (Ocean Conservancy 2010).

Fish entanglement occurs most frequently at or just below the surface or in the water column where objects are suspended. A smaller number involve objects on the seafloor, particularly abandoned fishing gear designed to catch bottom fish or invertebrates (Ocean Conservancy 2010). More fish species are entangled in coastal waters and the continental shelf than elsewhere in the marine environment because of higher concentrations of human activity, higher fish abundances, and greater species diversity (Helfman et al. 2009; Macfadyen et al. 2009).

The TYMSs structural components would be large in diameter, taut, and too large to entangle a fish. In addition, anchor lines would be separated by hundreds of feet as they radiated away from the vessel and would not be laterally connected to other lines, thereby avoiding the creation of a “web effect.”

Lighting

Short-term, minor, adverse, direct impacts on fish would occur as a result of lighting used during construction. Lighting used during construction would primarily be limited to the vessels (e.g., navigation lights, spotlights, decklights) used to illuminate the work area both on the vessel and on the water. Lights would be downshielded to illuminate the deck only and would not intentionally illuminate the surrounding waters. The increased lighting associated with construction may alter the behavior of individual fish in the immediate vicinity. This temporary change in the behaior of individual fish is not expected to have any population-level consequences or to affect the overall health of fish stocks. Artificial lighting would not impact fishes.

Alteration to Prey Species Abundance and Distribution

The FLNGVs and other structures of the proposed Port are likely to function as fish-attracting or fish-aggregating devices (FAD), meaning that migratory and reef fish species, especially tuna, may congregate near them (BOEM 2012a). Fixed oil and gas platforms are known to act as FADs, which are typically defined as floating objects moored at specific locations in the ocean to attract pelagic fishes. Virtually any floating object in open water can serve as a FAD. Commercial, recreational, and artisanal fishers throughout the world purposefully deploy FADs to draw pelagic fish to targeted capture areas (Fisheries and Aquaculture 2010). It is debatable whether these devices actually cause fish to aggregate or only attract fish. Ideally, FADs function as floating reefs in the sense that they provide clean attachment locations for algae and invertebrates, which then provide forage, shelter, and structure for mobile organisms.

The proposed Port would not create complex habitat in the same way as a fixed platform because the FLNGVs are designed not to accumulate encrusting organisms on their hulls. However, as a large floating structure, the proposed Port would serve as a temporary aggregating locale for mobile pelagic fishes. The commercial fishing interests that harvest tuna from the Gulf of Mexico would not set their lines beneath the FLNGVs, and so tuna and other pelagic fishes that were attracted to the proposed Port would be temporarily protected from capture. The physical presence of the proposed Port would have a minor temporary beneficial effect on pelagic fishes such as tuna because it would create a temporary no-take zone that would protect some individuals from fishing pressure.

4.3.8.2 Impacts of Operation on Fisheries

Benthic Habitat

Impacts on benthic resources and habitat are discussed in Section 4.3.6. Long-term, negligible, adverse impacts on demersal fish would occur as a result of seafloor disturbance in the immediate vicinity of the DWP.

Turbidity

Long-term, negligible, adverse impacts on fish would occur as a result of turbidity increases associated with operation of the proposed Port. The discussion of impacts of turbidity on fishes during the construction phase is applicable to the operation phase.

LNGC Ballast Water Discharge

Long-term, negligible adverse impacts would result from LNGCs releasing ballast water in the proposed Project area. All LNGCs are required to manage ballast water discharges in compliance with USCG regulations. Chemicals used to treat ballast water prior to discharge must be approved by the USCG and meet environmental safety standards. Moreover, the infrequent visits by LNGCs and the dynamic open water setting of the DWP would not allow for any accumulation of potentially toxic chemicals in the water surrounding the DWP. Impacts of ballast water discharge on fisheries would be negligible.

Routine Discharges

Routine discharges would result in long-term, negligible, adverse impacts on fish, comparable to those described for the construction phase of the proposed Port. Routine discharges would include deck runoff from the FLNGVs, support vessels, and LNGCs. Due to the higher density of the RO plume, sinking may locally expose pelagic and benthic organisms to higher salinity regimes in the areas of the FLNGVs. Seagrasses were found to be negatively affected at salinities of 38 to 39 ppth (Jenkins et al. 2012). In some cases, increases in salinity of 1 to 2 ppth have been shown to affect biota within influence of the brine discharge (Jenkins et al. 2012). However, the water depths at the proposed Port would allow for mixing within the water column and for dilution of the brine discharge plume within 328 ft (100 m) from release (see Section 4.2.2.2 and Appendix N). Similarly, for essential generator cooling water discharges, given that the temperature of the generator engine prior to tests would be near ambient air temperature and the heat buildup in a 30-minute test would be limited, the expected seawater temperature would increase by 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). More mobile, pelagic species such as fish would be able to avoid the plume within the water column during mixing of the plume within the water column. Therefore, the impacts associated with continuous brine discharge and intermittent temperature discharge are considered long-term and represent a minor adverse impact on marine vegetative communities, but would be localized to within a small area around the discharge point (within 328 ft [100 m] from the discharge source). All discharges would be permitted under the USEPA's NPDES permit.

Accidental Releases of Fuel, Oil, and Other Chemicals

Accidental chemical releases would result in short-term, minor, adverse impacts on fish, comparable to those described for the construction phase of the proposed Port. Vessels associated with service and supply operations would be equipped with spill containment and cleanup equipment to respond to small, accidental releases of bunkers, lubricants, or other chemicals. In the event of a large spill, an emergency response would be mobilized from shore. Impacts associated with these activities would be avoided or minimized by protective measures developed in a SPCC Plan and FRP, as discussed in Section 4.2.1.5.

LNG Spills

Short-term, minor, direct adverse impacts on fish would occur in the unlikely event of an LNG spill. LNG spills and impacts on the water column are described in Section 4.2.2.2. However, if an LNG spill were to occur, potential impacts would include exposure to low-temperature LNG at the water surface, possibly resulting in frostbite or death and asphyxiation by natural gas vapors above the surface of the water. These transient impacts would likely occur in the immediate vicinity of the spill location.

Planned and Unplanned Maintenance and Repair

Beyond impacts associated with vessel transits, including intake and discharge of water, and the risk of entrainment of organisms, no adverse impacts on fisheries are expected to occur during planned and unplanned maintenance and repair.

Noise

Long-term, minor, adverse impacts on fish would result from noise generated during proposed Port operation. Support vessel and FLNGV noise is the primary noise-producing factor during operations. A more detailed discussion of underwater noise resulting from operation activities associated with the proposed Port is provided in Section 4.10.2. The impacts of noise on fishes discussed above for the construction phase are applicable to the operations phase.

See Section 4.4.2.2 for effects of operational noise on fish.

Lighting

Long-term, minor, adverse, direct impacts on fish would occur as a result of lighting on the offshore facilities and LNGCs. During nighttime operations, offshore service vessels would be outfitted with identification lights and work areas would be illuminated for safety. Only the minimum amount of lighting necessary to maintain appropriate safety conditions would be used. Impacts are identical to those described for the construction phase, but longer in duration.

Alteration to Prey Species Abundance and Distribution

The discussion above regarding the use of the TYMS and FLNGVs as an FAD and artificial reef is equally relevant to the operation phase of the proposed Project. The proposed Port overall is expected to increase hard-bottom habitat and support greater diversity and abundance of associated algae and invertebrate species. Those attached species would in turn support mobile predators, creating a complex underwater ecosystem supported by the structure. Because commercial and recreational harvest of fish and shrimp would be prohibited in the immediate area, distribution and abundance of both predator and prey species would be altered compared with the no-project condition. Determination of whether the impact on fisheries is beneficial or adverse depends entirely on which component of fisheries is under consideration. Overall, the impact of a combined increase in hard-bottom habitat and decrease in harvest would have a long-term, negligible beneficial impact on fisheries.

4.3.8.3 Impacts of Decommissioning on Fisheries

Support Vessel Intake and Discharges

Adverse, short-term, minor impacts on fisheries would occur during decommissioning. Decommissioning would be restricted to the TYMS and FLNGV area only; no pipelines would be removed.

Accidental Releases of Fuel, Oil, and Other Chemicals

The probability of chemical releases during decommissioning is expected to be lower than during operations because decommissioning is a 10-week process focused on removing materials from the area. Any small fuel spill (less than or equal to 1 barrel) would be expected to dissipate or be immediately contained and cleaned up as described in Delfin LNG's FRP.

Noise

Noise associated with decommissioning would be similar to construction noise, albeit at a lower magnitude because no pile driving would occur. Noise would be associated with the additional vessels that would be on site for the 10-week decommissioning period. No explosives would be used. Impacts of noise on fisheries during decommissioning would be short-term and negligible.

Vessel Traffic

Vessel traffic during decommissioning would change from the large carriers typical of operations to smaller transport vessels used to carry materials and personnel. Impacts of vessel traffic on fisheries resources would be negligible.

Alteration to Prey Species Abundance and Distribution

Decommissioning would allow typical plankton distribution and abundance to return to the area formerly occupied by the DWP. The long-term impact of decommissioning is beneficial to plankton, but negligible.

4.3.9 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.3.9.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore biological resources including ESA-listed species.

4.3.9.2 Alternative Deepwater Port Designs

A fixed platform-based unit would impact a larger area of seafloor than the proposed Port which would result in similar but slightly greater impacts on listed species, plankton, mobile invertebrates, fish, and birds due to the larger seafloor footprint.

4.3.9.3 Alternative Cooling Media

The proposed air-cooled system represents a reduction in seawater use of over 98 percent compared with an open-loop process cooling system, reducing the intake of seawater by millions of gallons per day which reduces entrainment and mortality of ichthyoplankton, impingement mortality of larger fish, and the degree of localized seawater heating caused by open-loop systems.

An alternative open-loop system would result in a minor loss of ichthyoplankton by entrainment or impingement. An open-loop, water-cooled system for liquefaction utilizes a once-through water-cooling system that requires a substantial volume of seawater to remove heat from the process. Cooling water intake systems can result in both impingement mortality and entrainment mortality of aquatic organisms due to high seawater intake rates needed to meet required the volumes sufficient for liquefaction process cooling. Fish and other organisms that are pinned to intake screens are “impinged,” while smaller fish, eggs, and larvae that are swept through the structure with the cooling water are “entrained.” The amount of cooling seawater required depends on the acceptable temperature rise between the intake and discharge temperature (ΔT of seawater). Temperature rise in seawater can be detrimental to the local marine life if the heat cannot be dispersed by the sea currents and wave action in a reasonable amount of time. Water withdrawal demands for cooling using the air-based cooling system design would be limited to emergency generator testing for each of the FLNGVs and would be based on only periodic testing durations under routine FLNGV operations at a withdrawal rate of 600 gpm, resulting in a ΔT of 1°F or less within 328 ft (100 m) from the discharge source (see Section 4.2.2.2 and Appendix N). An open-loop system would use between 72 and 290 Mgal of seawater per day per FLNGV, depending on the acceptable increase of ambient seawater temperature. Secondary biological effects from the open-loop system are fish impingement on intake screens.

The alternative cooling media would have no different impacts on bird or marine mammal resources than those described for the proposed cooling media (air-cooled system).

4.3.9.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore biological resources associated with use of this alternative because the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.3.9.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). The increased depth at Alternatives 2 and 3 could require longer piles and additional pile-driving durations. This could result in additional noise impacts on fish, marine mammals, and sea turtles in the vicinity of construction activities.

4.3.9.6 Alternative Anchoring Systems

Sediment Displacement and Increased Turbidity

During installation, all anchor alternatives would have short-term turbidity and sedimentation impacts. These impacts would be limited to the duration of installation. It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on benthic habitat. Installation of a gravity-based anchor would result in the greatest disturbance due to a larger footprint, followed by the fluke anchor system, which would result in disturbance due to the necessary pulling of the anchor in the seafloor.

Fisheries Impacts

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on fisheries. Suction anchors, by virtue of pumping out water from inside the caisson would have an impact on the zooplankton within that water column, which the other alternatives avoid. Gravity-based anchor structures would result in a direct loss of existing fish habitat of approximately 2,500 ft^2 per anchor structure. However, the gravity-based anchor system structures would result in the creation of hard substrate which would likely result in an artificial reef sustaining development of new biotic communities that have a potential to support marine populations. Such gravity-based anchor reefs would not be available to commercial and recreational fisherman so would not result in any direct positive economic impact.

Noise Impacts

For suction anchor and gravity-based anchors, sound generated by support vessel and barge movements and the thrusters of DP vessels, if used, would be the dominant source of underwater noise during anchor installation activities. An increase in underwater noise would be anticipated with grouted piles, mostly attributable to the use of drilling equipment. Noise impacts are expected to be greatest for driven piles due to the pulsed sounds of the hammer striking the pile. All noise impacts would be temporary for the duration of the installation.

Decommissioning Impacts

During decommissioning, driven pile and grouted pile anchors would be cut below the surface and abandoned in place. There would be a short-term and minor disturbance to surface sediments during this activity. Fluke anchors could be similarly abandoned in place with little disturbance to sediments, or backed out and recovered, resulting in short-term, minor disturbance to sediments, benthic habitat, and increased turbidity. For gravity-based anchors, they could be abandoned in place, potentially creating artificial reef habitat. If removed, it is likely that there would be short-term and minor disturbance to sediments during removal. The suction anchor could also be abandoned in place with little disturbance to sediments, or backed out and recovered, resulting in short-term, minor disturbance to sediments, benthic habitat, zooplankton, and increased turbidity. Backing out the suction anchor, achieved by pumping seawater into the caisson to pressurize and raise the anchor, would also result in further entrainment impacts. It is expected that this impact would be temporary because the area would recover to preconstruction conditions.

Bird Impacts

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on fisheries, which in turn has the least impact on birds that forage on fish.

Marine Mammal Impacts

The five different anchor designs considered in the alternatives analysis for the proposed Port would have a range of different effects on marine mammals. The driven piles and grouted pile anchors would have an increased direct effect on marine mammals due to the installation disturbance and noise associated with the piles. An increase in underwater noise would be anticipated with grouted piles especially from the used of drilling equipment. Noise impacts are expected to be greatest for driven piles due to the pulsed sounds of the hammer striking the pile. All noise impacts would be temporary for the duration of the installation. For suction anchor and gravity-based anchors, the increased sound generated by support vessel and barge movements and the thrusters of DP vessels would produce greater underwater noise levels during anchor installation activities which in turn would result in increased direct, adverse impacts on marine mammals. The alternative anchoring systems proposed are expected to have increased adverse impacts on marine mammals than the proposed Port.

Anchor Alternatives Conclusions

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on fisheries, which in turn would have the least impact on birds that forage on fish. The five different anchor designs considered in the alternatives analysis for the proposed Port would have a range of different effects on listed marine mammals. The driven piles and grouted pile anchors would have an increased direct effect on listed marine mammals due to the installation disturbance and noise associated with the piles. An increase in underwater noise would be anticipated with grouted piles especially from the used of drilling equipment. Noise impacts are expected to be greatest for driven piles due to the pulsed sounds of the hammer striking the pile. All noise impacts would be temporary for the duration of the installation however would be great enough to cause impacts while they are being produced. For suction anchor and gravity-based anchors, the increased sound generated by support vessel and barge movements and the thrusters of DP vessels would produce greater underwater noise levels during anchor installation activities which in turn would result in increased direct, adverse impacts on listed marine mammals. The alternative anchoring systems proposed are expected to have increased adverse impacts on listed marine mammals than the proposed Port.

Given the environmental and technical considerations, the driven pile and suction anchor systems are characterized by several key advantages including a smaller footprint and decreased number of required support vessel transits during installation. Suction anchors are mostly used in a clay and fine sediment soil condition with limited stratification. Driven piles are generally used in sediment conditions consisting of more non-cohesive soil, such as sand, silt, and/or a more stratified conditions. In addition, driven piles have the ability to restrain the TYMS from large overturning events.

4.3.10 Best Management Practices

BMPs regarding water resources, air quality, and noise would also minimize impacts on offshore biological resources. Additionally, Delfin LNG has committed to the following BMPs:

- **BMP-14:** Delfin LNG will institute impact minimization and mitigation measures throughout the course of the proposed Project. Delfin LNG will implement mitigations such as, but not limited to, use of lowest noise-producing impact hammer available, use of a cofferdam system (including the introduction of bubbles within the annulus between the pile and the cofferdam) to reduce the transmission of marine noise), use of the pile-driving soft start ramp-up procedures preceded by clearing the surrounding waters by a PSO, and call for a suspension of pile driving by the PSO should a protected species be observed in proximity to the active pile driving operation. Prior to operating at full capacity, Delfin LNG will implement a "soft start" with several initial hammer strikes at less than full capacity (i.e., approximately 40–60 percent energy levels) with no less than a 1-minute interval between each strike. PSOs will be present to conduct surveys before, during, and after all pile-driving activities to monitor for marine mammals within designated ZOIs.
- **BMP-15:** The proposed Port will be designed and permitted under the DWPA, and thus will be required to meet all lighting stipulations as noted in 33 CFR, Part 149. To this end, Delfin LNG will limit, to the greatest extent possible, the amount of total lighting used on the proposed Port to that required for safety and navigational concerns only. As such, to reduce the disruptive effects of lighting, all lighting at the proposed Port will be down-shielded to the greatest extent possible to reduce light dispersion to a minimum.
- **BMP-16:** Standard mitigations for marine mammal monitoring will be in place during construction, operation, and decommissioning.
- **BMP-17:** Delfin LNG will institute the procedures described in NOAA Fisheries SERO (2008) guidelines for "Vessel Strike Avoidance Measures and Reporting for Mariners," which call for vessels to maintain a vigilant watch for marine mammals and sea turtles to avoid striking protected species. Delfin LNG will adhere to the reporting procedures related to injured or dead protected species described in these guidelines.
- **BMP-18:** To prevent or mitigate potential noise impacts on marine mammals and sea turtle species, Delfin LNG will maintain minimal safe operating power at all times for vessels with DP thrusters. Each of Delfin LNG's FLNGVs will not engage thrusters if it is not required to do so. Additionally, if a marine mammal or sea turtle is detected within 500 m of a DP vessel, the responsible crew member will alert the vessel operators to minimize thruster power down to the absolute lowest safe operating levels. Other vessels in the immediate vicinity of the vessel that had an animal detected within 500 m will also be instructed to reduce to slow speed and minimum safe operating power consistent with the activities being performed.
- **BMP-19:** Delfin LNG will follow the recommendations of the USFWS to take all measures possible to minimize the risk of gas flaring to migratory birds. Delfin LNG has agreed to avoid gas flaring at night, during low visibility (i.e., fog, storm events), and during peak migration (mid-March through April and September through October) to the maximum extent feasible. However, since flares are installed to accommodate process upset conditions as well as gas venting that might be required as a result of specific maintenance and safety procedures, random flaring events might occur at night, during low visibility, and/or peak migration periods.
- **BMP-20:** Delfin LNG will commit to utilizing the USFWS voluntary guidelines for communication tower design, siting, construction, and operation to the extent that these guidelines apply to the Delfin LNG project flaring tower. The planned tower design is lattice structure without guy wires which is consistent with the USFWS recommendations. Should the top of the flare tower exceed 200 ft above sea level, the FAA will require pilot warning lights (flashing red or white strobe).
- **BMP-21:** Delfin LNG will follow USFWS recommendations to install cone-shaped mesh covers on the open vents of all the process vessels and storage tanks to minimize bird perching to the maximum extent feasible.

- **BMP-22:** Delfin LNG will consult regularly with the USFWS to determine the peak migration periods for the site of the Delfin LNG project.
- **BMP-23:** Delfin LNG will commit to monitoring for any bird mortality consistent with any recommendations from USFWS following each flaring event. The survey should be rigorous enough to detect any use by migratory birds of the offshore LNG facility and should encompass both the spring and fall migrations. Results of the fatality monitoring will be reported to the USFWS in order to assess any need for additional conservation measures that may be required to further reduce any bird fatalities.

4.3.11 Recommendations and Conclusions

Impacts on biological resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented. Additionally, as noted in Table 4.3-1, potential effects from construction and operational activities may affect but are not likely to adversely affect ESA-listed species.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.3-11.

Table 4.3-11. Summary of Impacts for Offshore Biological Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
Construction			
Marine Mammals & Sea Turtles			
Construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments	During the 7.5-month pipeline construction period and during mooring structure installation intermittently during the 5.5-year construction period	BMP-10; BMP-11	Short-term, minor, adverse
Hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Short-term, minor, adverse
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems	Intermittent during the 5.5-year construction period	BMP-2	Short-term, minor, adverse
Water intake associated with FLNGV commissioning	Once each for the 4 FLNGVs – see Table 4.2-10	BMP-1; BMP-2; BMP-12	Negligible
Vessel and aircraft noise	Intermittent during the 5.5-year construction period	BMP-14; BMP-18; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, minor to moderate, adverse
Anchoring	During the 5.5-year construction period	Construction Vessel Anchoring Plan (Appendix O)	Short-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
Artificial lighting	During the 5.5-year construction period	BMP-15	Negligible
Increased vessel traffic	Unlikely during the 5.5-year construction period	BMP-17; BMP-30	Short-term, minor, adverse
Marine debris	Accidental during the 5.5-year construction period	BMP-2	Short-term, negligible to minor, adverse
Periodic pipeline maintenance	During the 5.5-year construction period	None	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, moderate to major, adverse
Birds			
Construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments	During the 7.5-month pipeline construction period and during mooring structure installation intermittently during the 5.5-year construction period	BMP-10; BMP-11; BMP-22	Short-term, minor, adverse
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems	Intermittent during the 5.5-year construction period	BMP-2	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, moderate to major, adverse
Vessel and aircraft noise	Intermittent during the 5.5-year construction period	BMP-42; BMP-43; BMP-44	Short-term, minor to moderate, adverse
Artificial lighting	During the 5.5-year construction period	BMP-15	Short-term, minor, adverse
Increased vessel traffic	During the 5.5-year construction period	BMP-30; BMP-31; BMP-32; BMP-33	Negligible
Marine debris	Accidental during the 5.5-year construction period	BMP-2	Negligible
Marine Vegetative Communities			
Hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Short-term, minor, adverse
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;	Intermittent during the 5.5-year construction period	BMP-1; BMP-2	Short-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
Water intake and discharge associated with FLNGV commissioning	During the commissioning of each of the 4 FLNGVs – see Table 4.2-10	BMP-2; BMP-12	Short-term, minor, adverse
Increased vessel traffic	Unlikely during the 5.5-year construction period	BMP-17; BMP-30	Short-term, major, adverse
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, moderate to major, adverse
Benthic Resources			
Construction of pipeline laterals and WC 167 bypass	Approximately 60 acres during the 7.5-month construction period	BMP-10; BMP-11; BMP-24;	Short-term, minor, adverse
Construction of mooring platforms	1-2 acres during 5.5-year construction period	BMP-10; BMP-11; BMP-24;	Negligible
Hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Negligible
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems	Intermittent during the 5.5-year construction period	BMP-2	Negligible
Anchoring	During the 5.5-year construction period	Construction Vessel Anchoring Plan (Appendix O)	Short-term, minor, adverse
Periodic pipeline maintenance	During the 5.5-year construction period	None	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Negligible
Plankton			
Construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments	During the 7.5-month pipeline construction period and during mooring structure installation intermittently during the 5.5-year construction period	BMP-10; BMP-11	Short-term, minor, adverse
Hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Short-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems;	Intermittent during the 5.5-year construction period	BMP-1; BMP-2	Short-term, minor, adverse
Water intake associated with FLNGV commissioning	During the commissioning of each of the 4 FLNGVs – see Table 4.2-10	BMP-2; BMP-12	Short-term, minor, adverse
Vessel and aircraft noise	Intermittent during the 5.5-year construction period	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, minor to moderate, adverse
Anchoring	During the 5.5-year construction period	Construction Vessel Anchoring Plan (Appendix O)	Short-term, minor, adverse
Artificial lighting	During the 5.5-year construction period	BMP-15	Negligible
Increased vessel traffic	Unlikely during the 5.5-year construction period	BMP-17; BMP-30	Short-term, minor, adverse
Marine debris	Accidental during the 5.5-year construction period	BMP-2	Short-term, negligible to minor, adverse
Periodic pipeline maintenance	During the 5.5-year construction period	None	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, moderate to major, adverse
Fisheries Resources			
Construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments	During the 7.5-month pipeline construction period and during mooring structure installation intermittently during the 5.5-year construction period	BMP-10; BMP-11	Negligible
Hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline.	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	BMP-2; BMP-6; BMP-7	Short-term, minor, adverse
FLNGV and LNGC construction intake and discharges including cooling water, sanitary systems, bilge, ballast control and other service water systems	Intermittent during the 5.5-year construction period	BMP-1; BMP-2	Short-term, minor, adverse
Water intake associated with FLNGV commissioning	Once each for the 4 FLNGVs – see Table 4.2-10	BMP-2; BMP-12	Short-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
Vessel and aircraft noise	Intermittent during the 5.5-year construction period	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, minor, adverse
Anchoring	During the 5.5-year construction period	Construction Vessel Anchoring Plan (Appendix O)	Short-term, minor, adverse
Artificial lighting	During the 5.5-year construction period	BMP-15	Short-term, minor, adverse
Increased vessel traffic	Unlikely during the 5.5-year construction period	BMP-30; BMP-31; BMP-32	Negligible
Marine debris	Accidental during the 5.5-year construction period	BMP-2	Negligible
Periodic pipeline maintenance	During the 5.5-year construction period	None	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, negligible to major, adverse
Operation			
Marine Mammals & Sea Turtles			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation – see Table 4.2-10	BMP-2; BMP-9; BMP-12; BMP-13	Long-term, minor, adverse
Accidental releases of LNG, fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, minor to major, adverse
Vessel and aircraft noise	During port operation	BMP-18; BMP-42; BMP-44; BMP-45	Long-term, minor, adverse
Increased vessel traffic	During port operation	BMP-17; BMP-30	Long-term, minor, adverse
Marine debris	Accidental during port operation	BMP-2	Negligible
Artificial lighting	During port operation	BMP-15	Negligible
Alteration to prey species	During port operation	None	Negligible
Introduction of nonindigenous species	Arrival of LNGCs (up to 160/year)	BMP-13	Negligible
Birds			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-2; BMP-9; BMP-10; BMP-11; BMP-12; BMP-13	Negligible
Accidental releases of LNG, fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, minor to major, adverse
Vessel and aircraft noise	During port operation	BMP-42; BMP-44; BMP-45	Long-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
Increased vessel traffic	During port operation	BMP-30	Long-term, minor, adverse
Marine debris	Accidental during port operation	BMP-2; BMP-13	Short-term, minor, adverse
Artificial lighting	During port operation	BMP-15	Short-term, minor, adverse
Gas flaring	Intermittent during port operation, as needed for safety	BMP-19; BMP-20; BMP-21; BMP-22; BMP-23	Negligible
Introduction of nonindigenous species	Arrival of LNGCs (up to 160/year)	BMP-13	Negligible
Marine Vegetative Communities			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-2; BMP-9; BMP-12; BMP-13	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short –term, minor to major, adverse
FLNGV and LNGC operational intakes (entrainment) including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-1; BMP-2; BMP-12; BMP-13	Long-term, minor, adverse
Benthic Resources			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-10; BMP-11	Negligible
Introduction of nonindigenous species	During port operation	BMP-13	Negligible
Accidental releases of LNG, fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Negligible
Plankton			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-2; BMP-9; BMP-12; BMP-13	Negligible
Accidental releases of fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short –term, minor to major, adverse
Vessel and aircraft noise	During port operation	BMP-42; BMP-44; BMP-45	Long-term, minor, adverse

Table 4.3-11. Summary of Impacts for Offshore Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect /a
FLNGV and LNGC operational intakes (entrainment) including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-1; BMP-2; BMP-12; BMP-13	Long-term, minor, adverse
Accidental releases of LNG, fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8; BMP-12; BMP-13	Negligible
Introduction of nonindigenous species	Arrival of LNGCs (up to 160/year)	BMP-13	Negligible
Fisheries Resources			
FLNGV and LNGC operational discharges including desalination system, water curtain, firewater pump testing, ballast water, bilge water, and sanitary water	During port operation	BMP-2; BMP-9; BMP-12	Negligible
Accidental releases of LNG, fuel, oil and other chemicals	Unlikely, but could occur during port operation	BMP-2; BMP-3; BMP-4; BMP-6; BMP-8	Short-term, minor, adverse
Vessel and aircraft noise	During port operation	BMP-42; BMP-44; BMP-45	Long-term, minor, adverse
Alteration to prey species	During port operation	None	Long-term, negligible
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on biological resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

Notes:
a/ Listed potential effects from activities may affect but are not likely to adversely affect ESA-listed species.
Key:
FLNGV = floating liquefied natural gas vessel; gpm = gallon per minute; HIOS = High Island Offshore System; LNGC = liquefied natural gas carrier; Mgal = million gallons; WC = West Cameron

4.4 Essential Fish Habitat

Activities associated with construction and operation of the proposed Project that would impact EFH include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which would lead to resuspension of sediments;
- hydrostatic testing of the UTOS and HIOS pipeline systems, pipeline laterals, and WC 167 bypass pipeline;
- FLNGV and LNGC operational withdrawals and discharges;
- vessel and aircraft noise;
- anchoring;
- artificial lighting;
- increased vessel traffic;

- marine debris;
- periodic pipeline maintenance; and
- accidental releases of fuel, oil, and other chemicals during construction and operations.

Construction, operation, and decommissioning of the proposed Port could result in impacts on the biological, chemical, or physical properties of the environment (water column and sediment) designated as EFH (described in Section 3.4). The following sections describe potential impacts on EFH, and the species supported by EFH, that could result from construction, operation, and decommissioning of the proposed Port.

EFH is broadly defined by the Act (now called the Magnuson-Stevens Act or the Sustainable Fisheries Act) to include “those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity.” This language is interpreted or described in the 1997 Interim Final Rule which states that waters include aquatic areas and their associated physical, chemical, and biological properties that are used by fish and may include historic areas if appropriate; substrate includes sediment, hard bottom, structures underlying the waters, and associated biological communities; necessary means the habitat required to support a sustainable fishery and the managed species’ contribution to a healthy ecosystem; and “spawning, breeding, feeding, or growth to maturity” covers a species’ full life cycle (62 Federal Register 66551, Section 600.10 Definitions).

Effects are described in terms of significance, with a significant effect indicating a measureable or observable decrease in survival, or reproductive success of a managed species or a measureable decrease in prey abundance or quality within the ROI. A measureable or noticeable change in some aspect of the habitat, such as turbidity, that does not result in harm to the managed species or degradation of the EFH is not considered major. Temporal descriptors are based on professional judgment: temporary refers to a few hours or days, whereas short-term describes an effect lasting one to several weeks. A finding of “no effect” indicates that any effect is within the range of natural variability of the feature being described.

The proposed Project would have either no adverse effect or minimal adverse effect on EFH and managed species in the proposed Project area; contemporaneous beneficial effects accrue from aspects of the proposed Project. The ubiquitous presence of numerous overlapping categories of EFH for multiple species make it infeasible to develop an effect determination for each unique combination of species/life stage/EFH. The preceding analysis, coupled with the extensive details of the proposed Project presented in earlier chapters of this document, support the overall determination that no aspect of the proposed Project would result in substantial adverse effects on EFH. In a comment received by the USCG on the docket (USCG-2015-0472-0090) dated August 29, 2016, NOAA Fisheries concurred with the conclusion of the EFH Assessment that proposed Project implementation would not result in a substantial adverse effect to EFH or Federally managed fishery species. In addition, NOAA Fisheries has concluded that further coordination pursuant to requirements of the Magnuson-Stevens Fishery Conservation and Management Act is unnecessary for this proposed Project.

Impacts to EFH were evaluated based on reported effects of similar offshore marine projects, primarily associated with deepwater ports or other energy-related infrastructure. Potential impacts of construction, operation, and decommissioning on EFH are summarized in Table 4.4-1.

Table 4.4-1. Summary of Potential Impacts on EFH during Project Life Cycle

Proposed Action Component/Impacts	Phase	Impact on Water Column	Impact on Soft-bottom Substrate
Placement of terminal components	C	Short-term moderate increase in turbidity Short-term moderate increase in noise	Short-term minor displacement of sediments Secondary short-term negligible impact on prey species
Installation and hydrostatic testing of pipelines	C	Short-term moderate increase in turbidity Permanent loss of ichthyoplankton	Short-term minor displacement of sediments Secondary short-term negligible impact on prey species
Treated water discharge	O	Long-term negligible impact on water quality	Long-term negligible impact on sediment quality
Vessel and aircraft noise	C, O, D	No expected impact	No expected impact
Anchoring	C, D	Temporary minor increase in turbidity	Permanent minor displacement of sediments
Artificial lighting	C, O, D	Long-term negligible impact on attraction of ichthyoplankton	No expected impact
Presence of terminal	C, O	Long-term minor beneficial impact as artificial reef Long-term minor beneficial impact of safety/exclusion zone as refuge from fishing	Permanent negligible displacement of sediments Long-term minor beneficial impact as artificial reef Long-term minor beneficial impact of safety/exclusion zone as refuge from fishing
Increased vessel traffic	C, O, D	No expected impact	No expected impact
Marine debris	C, O	No expected impact	No expected impact
Accidental release	C, O, D	Small release: Transient minor impacts Large (Catastrophic) release: Short-term major impact on living resources in immediate area (freezing tissue)	No expected impact
Removal of Structures	D	Short-term negligible increase in turbidity and noise	Permanent negligible loss of hard-bottom habitat and attached organisms
Key: C = Construction Phase; O = Operations Phase; D = Decommissioning Phase			

4.4.1 Impacts of Construction

Several construction-related activities have the potential to affect EFH or managed species:

- resuspension of sediments during trenching and other substrate-disturbing activities, resulting in increased turbidities and subsequent respiratory effects on some species; foraging efficiencies may be increased or reduced, depending on species;
- smothering and crushing by emplacement of equipment or anchors may alter distribution and abundance of benthic species in the immediate project area; managed species may experience increased foraging opportunities as they take advantage of dead, injured, or disoriented prey;
- entrainment and impingement of eggs/larvae and juveniles, respectively, during hydrostatic testing;
- effects of inadvertent chemical releases from construction and support vessels at the site;
- noise-related effects resulting from pile driving during construction; and
- increase in marine debris.

4.4.1.1 Resuspension of Sediments/Turbidity

Turbidity associated with the proposed Port would have no adverse effect or minimal adverse effect on EFH and managed species. Adverse impacts would be indirect, short-term, and minor. During construction activities, managed species and EFH may be affected by disturbed sediments, which increase turbidity in the water column. Effects would be strictly physical, as no chemical contaminants were reported in recent analyses of sediment and water at the proposed Project site (see Section 3.5.5.6).

Pipelines would be installed by jet-trenching (using a jet-sled trencher). A jetted trench typically has a V-shaped cross-section, ranging in width from approximately 30 ft (9 m) at the trench top to 10 ft (3 m) at the trench bottom. The greatest potential to affect surface waters would occur from suspension or deposition of sediments caused by trenching or jetting the pipeline. Trenching or jetting would suspend sediments in the water column for a period of time depending on the size of the sediments. Coarser sediments would fall out and resettle quickly (hours), while finer sediments could remain suspended for longer periods of time (days).

Considering the cumulative 5 miles (8 km, or 26,300 ft) of pipeline trenching, and conservatively predicting a 100-ft-wide corridor that could be affected over a short time period by deposition to some degree under the “worst-case” scenario, approximately 60 acres (24.4 hectares [ha]) of benthic habitat could be temporarily affected by pipeline installation. An additional 1 to 2 acres (0.4 to 0.8 ha) of benthic habitat would be impacted by other substrate-disturbing activities, such as mooring construction, tie-in pits, and anchoring activities.

As a result of pipeline installation and other construction-related bottom disturbance activities (i.e., anchoring), the almost 5 miles (8 km) of new pipeline would result in the suspension of up to 1.4 million cubic ft (40,000 m^3) of sediment during pipeline installation (MMS 2001). Because of the fine-grained characteristics of the substrate within the ROI, it is expected that suspended sediment would be in the water column for only hours to days.

The adverse effects of increasing turbidity in coastal marine habitats are generally ascribed to algal blooms resulting from anthropogenic nutrient inputs (Lowe et al. 2015; Wegner et al. 2012). However, the effects of short-term localized increases in suspended sediment concentrations cannot be assumed comparable in either source or adversity to fishes. Turbidity is known to influence the outcomes of predator‑prey interactions through effects on perception of both species. What may be perceived as obstruction to a predator is protective cover to its prey. Moreover, not all predatory fish are strictly visual operators; other sensory modalities such as chemoreception and physical contact may offset reductions in vision in turbid environments (Lunt and Smee 2015).

Mobile species in an area of increased turbidity would relocate to clearer water if no foraging advantage was experienced. Generally, reported effects of elevated turbidities on fish are associated with long-term events, often mediated through primary habitat degradation, such as algal blooms or inputs of terrestrial sediments to a coastal habitat. No large-scale permanent increase in turbidity would occur as a result of the proposed Project.

4.4.1.2 Loss, Reduction, or Change of the Benthic Assemblage

Direct impacts from pipeline installation and other bottom-disturbing activities would result in adverse effects on benthic macroinvertebrates, with potential subsequent secondary adverse effects on managed species through reduction of forage species. Direct impacts on benthic organisms would include crushing, localized disruption, removal, turnover, and deposition of sediment in the immediate vicinity of the anchors and other similar structures. Considering the cumulative 5-mile (8 km, or 26,300 ft) of pipeline trenching, and conservatively predicting a 100-ft-wide corridor that could be affected over a short time period by deposition to some degree under the “worst-case” scenario, approximately 60 acres (24.4 hectares [ha]) of benthic habitat could be temporarily affected by pipeline installation. An additional 1 to

2 acres (0.4 to 0.8 ha) of benthic habitat would be impacted by other substrate-disturbing activities, such as mooring construction, tie-in pits, and anchoring activities.

Given that most benthic infauna live on or within the upper 6 inches (15 cm) of the sediment surface, it is expected that turnover and burial would result in the loss of these organisms. Generally, disturbance-related impacts on benthos would be temporary and reversible because native assemblages would either recolonize the affected area or a new community would develop as a result of immigration of animals from nearby areas or from larval settlement. In contrast to the direct harm that may befall some benthic species, mobile fishes such as coastal migratory pelagics, snappers, groupers, and others may experience increased foraging opportunities as they take advantage of dead, injured, or disoriented prey.

The disturbed area of soft-bottom sediments would be recolonized by larvae recruited from the overlying water or adjacent areas, but recovery may take several months (Germano et al. 1994) to years (Hughes et al. 2010). Species composition may shift during the recovery period as more species more tolerant of residual hydrocarbons return first, followed by other species only after the sediment returns to pre-drilling conditions (Netto et al. 2010). Many physical and biological factors affect the recolonization process, with one being the texture of the disturbed sediment. Any change in the texture of the material after the activity is completed may result in changes to the community that was present before activities took place. Additionally, overturned, deeper sediments may be hypoxic, resulting in longer periods of re-establishment of former communities. Generally, a resident benthic community is quite resilient and recovers relatively quickly from disturbances. As such, it is expected that impacted benthic communities would re-establish within a short time, and thus no long-term impacts on EFH species are expected.

The potential for direct and indirect adverse impacts from trenching and substrate disruption on managed species with EFH designated in the proposed Project area would likely differ from species to species, depending upon life history, habitat use (demersal vs. pelagic), distribution, and abundance. However, it is anticipated that short-term impacts would be limited to temporary displacement of juvenile and adult fish (both pelagic and demersal) during initial installation of proposed Project components.

4.4.1.3 Impacts to Ichthyoplankton from Pipeline Hydrostatic Testing

Hydrostatic testing of the former UTOS pipeline would require approximately 10.5 Mgal of water. The water would be withdrawn from the Gulf of Mexico at WC 167. The HIOS line would be need to be flooded with water withdrawn from the Gulf of Mexico at HI A264. Approximately 22.6 Mgal would be needed to fill the HIOS pipeline; another 0.9 Mgal would be needed for hydrostatic testing of all laterals. After the hydrostatic testing of the former UTOS pipeline, the proposed WC 167 bypass and the laterals to the FLNGVs would be installed. The UTOS and HIOS fill water would be tested for hydrocarbons and other contaminants. If necessary to meet water quality requirements, the water would be filtered and treated prior to discharge. After testing and any needed filtration and treating, the water would be discharged into the Gulf of Mexico at HI A264. The total water volume discharged from the UTOS and HIOS pipelines and the four laterals would be approximately 34.0 Mgal.

During hydrostatic testing, water would be pumped into the pipe and filtered through a size 100 mesh screen (mesh opening = 0.0059 inch [0.15 mm]) to prevent debris and foreign material from entering the pipeline. Impingement of juvenile and early stage adult fish and invertebrates on intake screens could occur during this process, and these individuals would likely be killed or injured. It is expected that the short filling duration during construction activities would limit impingement impacts.

Additionally, biocides, which typically contain copper and aluminum compounds, may be used during hydrostatic testing of the pipelines, with subsequent discharge into surrounding Gulf of Mexico waters. Laboratory experiments have shown high mortality of Atlantic herring eggs and larvae at copper concentrations of 30 micrograms per liter (μg/L) and 1,000 μg/L, respectively, and vertical migration of larvae was impaired when copper concentrations exceeded 300 μg/L (Baxter 1977). To eliminate impacts from biocide discharge into surrounding waters, Delfin LNG would pump hydrostatic test water from the pipeline into a diffuser to re-oxygenate the water before discharging it back into the marine environment. The diffuser would spread the discharged water within a sufficiently large area so that the biocide concentration in the seawater would be diluted to acceptable levels.

Any eggs or larvae entrained during hydrostatic testing would likely be killed, based on the mechanical pumping required for filling, the corrosion inhibitors and/or biocides expected to be used, and the time element for water retention required during pipe integrity tests.

The 59 Southeast Area Monitoring and Assessment Program (SEAMAP) stations within the established block had an overall density of 0.274 fish larvae/m^3 and 4.616 fish eggs/m^3, or an average of 1,037 larvae and 17,484 eggs in 1 Mgal of seawater (see Section 3.3.10). Using these average egg and larvae densities, the use of 34.0 Mgal (129,461 m^3) of seawater would result in the loss of approximately 35,000 larvae and 600,000 eggs (all taxa combined). An unknown fraction of these would be eggs and larvae of managed species. Entrainment would take place in a marine environment where natural mortality is high. Precise mortality estimates are not available, but consider that most managed marine fishes spawn thousands, if not hundreds of thousands, of eggs in a lifetime. For several EFH species in the Gulf of Mexico, annual fecundity can range from thousands to millions of eggs per spawn, e.g.:

- Red snapper – 220,000 to 320,000 eggs;
- King mackerel – 500,000 to more than 1,600,000 eggs;
- Spanish mackerel – 100,000 to 2,100,000 eggs;
- Swordfish – 1,000,000 to 4,000,000 eggs; and
- Lane snapper – 347,000 to 995,000 eggs.

Copious gamete production is an adaptive strategy of species survival where mortality is by far the norm. The survival to adulthood of only two egg is necessary to replace the parents. Each additional egg surviving to maturity would represent an enormous increase in the stock size. Therefore, it is very rare that survival processes occurring in ichthyoplankton are used to set subsequent adult stock levels, and such correlations are almost impossible to detect with oceanographic sampling. For this reason, significant effects to populations of ichthyoplankton as a result of offshore construction processes in the ROI would be nearly impossible to detect. Thus, considering the fecundity potential for all EFH species addressed, along with natural mortality expected, the limited and one-time entrainment of eggs and larvae during hydrostatic testing would cause no measureable impact on the populations of fisheries present in the northern Gulf of Mexico.

4.4.1.4 Small Spills from Support Vessels

The presence, noise, and exhaust fumes of vessels are not expected to affect underwater EFH. On rare occasions, a vessel may accidentally release a small volume of diesel fuel to the water. Diesel is lighter than water and readily volatilizes, so a small fuel spill (less than or equal to 1 barrel) would not affect any benthic EFH. Effects on the water column would be transient and negligible.

The quantity of fuel and chemicals in the proposed Project area is limited. Delfin LNG has plans in place to quickly identify and respond to any inadvertent release of chemicals (see Section 4.2.2.1). The specific procedures would vary depending on the product spilled, location, sea state, weather, and other immediate conditions. Regardless of the particular cleanup methods, a small spill would be quickly contained and recovered, causing no long-term impact on EFH. It is possible that a limited area of EFH could be temporarily affected by a small spill that caused a short-term impact on water quality. The proposed Project area represents a negligible fraction of the millions of acres of EFH in the Gulf of Mexico.

A small fuel or chemical spill (less than or equal to 1 barrel) is extremely unlikely to cause any significant impact beyond the immediate project area. The chemical would dissipate or be collected before it could be transported more than a few miles from the lease area (NOAA 2006). No long-term significant impacts on EFH would result from a small fuel or chemical spill under the proposed action.

4.4.1.5 Effects of Construction Noise on Fish

Marine fish can be affected by noise both physiologically and behaviorally. The majority of research involves studies of the physiological effect of impact pile driving on fish due to changes in water pressure. Fish with swim bladders would be more vulnerable to such pressure changes, which can cause capillaries to rupture or the swim bladder to rapidly expand and contract[27] (Caltrans 2001). Temporary loss of hearing (TTS or PTS) also may occur as a result of exposure to noise from impact pile driving (Popper and Hastings 2009a; Popper et al. 2005). When caged juvenile coho salmon (*Oncorhynchus kisutch*) were placed as close as 6.6 ft (2 m) to steel piles being impacted, no fish mortality was observed (Ruggerone et al. 2008).

Potential effects of exposure to continuous sound on marine fish include TTS, physical damage to the ear region, physiological stress responses, and behavioral responses such as startle response, alarm response, avoidance, and perhaps, lack of response due to masking of acoustic cues. Most of these effects appear to be either temporary or intermittent, and therefore, probably do not significantly impact the fish at a population level. The studies that resulted in physical damage to the fish ears used noise exposure levels and durations that were far more extreme than would be encountered under conditions similar to those expected at the proposed Port.

Fish do react to underwater noise from vessels and move out of the way, move to deeper depths, or change their schooling behavior. The received levels at which fish react are not known and apparently are somewhat variable, depending upon circumstances and species of fish. To assess the possible effects of underwater noise, it is best to examine proposed Project noise in relation to continuous noises routinely produced by other projects and activities, such as shipping and fishing, and pulsive noises produced by seismic exploration.

Most of the construction vessels used in the shallow water depths present at the proposed Port and along the proposed pipeline routes would be positioned by anchors and do not have installed thrusters. However, as described in Section 4.3.1, thrusters would likely be employed by a support vessel during construction.

Pulsive Sounds

The pulsive sounds expected during construction scenarios are much less intense than the pulses from the air guns used in Gulf of Mexico offshore seismic surveys by the oil and gas industry. Such surveys routinely have source levels of 250 decibels in reference to 1 μPa (dB re 1 μPa) at 1 m. The available information suggests that seismic exploration has minor to moderate impacts on fisheries resources and EFH (BOEM 2014). It is highly unlikely that the low levels of pulsed noise from construction activities would have any permanent effects on fish populations in the area.

Four TYMSs would be constructed to allow permanent mooring of each FLNGV. Construction of each TYMS would involve jacket and pilings installation, and each TYMS platform would require four pilings, which would be installed in sections. Each pile would require 1 to 1½ days for installation (time

[27] Hitting a steel pile with a large hammer produces sound that causes water pressure changes that impact fish. Sudden changes in water pressure can cause gases such as oxygen to come out of fish blood faster than normal, leading to a decompression sickness much like the bends that divers experience when they rise to the surface too fast. Pressure changes also affect a fish's swim bladder, an internal, air-filled sac that helps the fish maintain weightlessness at different water depths. Alternating pressure changes cause the swim bladder to quickly expand and compress, which punches and bruises neighboring organs and can rupture the swim bladder itself. (http://www.pnnl.gov/news/release.aspx?id=930)

includes welding, fit-up, and pile handling), for a total of 4 to 6 days for each TYMS platform, with an estimated strikes-per-day of 3,600.

Approach for Estimating Pile-Driving Noise Levels

A cooperative effort between several Federal and State transportation and resource agencies along the west coast of the United States resulted in the establishment of interim criteria for the onset of physical injury to fish exposed to underwater sounds generated by impact pile driving (Stadler and Woodbury 2009). NOAA Fisheries currently uses these criteria to assess potential impacts on the fishery resources under its purview resulting from pile driving in or near aquatic environments. The new criteria use two metrics: the SPL and the SEL. A potential onset of physical injury is determined if either the peak SPL exceeds 206 dB (re 1 µPa) or the SEL, accumulated over all pile strikes generally occurring within a single day, exceeds 187 dB (re 1 μPa^2/sec) for fishes 2 grams or larger, or 183 dB (re 1 μPa^2/sec) for smaller fishes.

Acoustic ZOIs for potential injury and behavioral disturbance thresholds were calculated based on mitigated source levels for impact-driven, 78-inch steel pipe piling within an air bubble-infused coffer dam. Affected area radii representing potential behavioral and injurious effects to fish were calculated based on the 2016 NOAA Greater Atlantic Regional Fisheries Office (GARFO) criteria for fish (GARFO 2016).

The GARFO criteria rely on the acoustic metrics of peak (pk) and root mean square (rms) of the anticipated SPL and SEL to define thresholds. The SPLpk is a measure of the maximum instantaneous sound pressure from a specified source. It is used as a metric for the criteria for effects of underwater sound on fish and marine mammals. SPLrms is primarily used in the assessment of the behavioral effects on fish. The SPLrms is the square root of the sum of the squares of the pressure contained within a defined period from the initial time to a final time (Equation 1; ICF Jones & Stokes, and Illingworth and Rodkin, Inc. 2009).

Equation 1:

$$SPL_{rms} = 20log_{10}(\left[\frac{1}{t_f - t_i}\int_{t_f}^{t_i} p^2\,(t)dt\right]^{1/2} / \, p_{ref})$$

Where:

p = pressure;
pref = reference pressure for water (1µPa);
ti = initial time; and
tf = final time.

Further, SEL is the constant sound level in one second, which has the same amount of acoustic energy as the original time-varying sound (i.e., the total energy of an event). SEL is calculated by summing the cumulative pressure squared over the time of the event. The accumulation of exposure over a designated period of time or number of instances of a sound is termed cSEL. The cSEL can be estimated from a representative single-strike SEL value and the number of strikes that likely would be required to place the pile at its final depth by using the following equation:

Cumulative SEL = Single Strike SEL + 10 log (# of pile strikes)

It was estimated in the original application that 3,600 pile strikes would occur per day. The cSEL is used for injury metrics in fish (GARFO 2016) and in revised impact metrics for marine mammals (NOAA Fisheries 2016b). To determine the affected area, the transmission loss (TL) of the sound was computed across varying ranges from the source. The practical spreading equation (Equation 2) was used to determine the amount of sound loss.

Equation 2:

$$TL = 15\ log10\ r$$

Where:

r = range (m)

Reference Sound Source Levels

The proposed Port includes installation of 78-inch- (2-m) diameter steel pipe piles within an air bubble-infused cofferdam. No directly comparable SPL measurement references were found for the proposed 78-inch steel pile. Therefore, measurements from piling of 96-inch cast-in-steel-shell piles for the Benicia-Martinez Bridge were used as proxies for the impact analysis (ICF Jones & Stokes and Illingworth and Rodkin Inc. 2009; California Department of Transportation 2015). In order to account for the smaller pile diameter considered in this analysis, the 96-inch proxy measurements were reduced by 5 dB to estimate the source level of the 78-inch piles. This modified source level was then reduced by 11 dB to account for the mitigative effects of an air bubble-infused cofferdam surrounding each pile and carried through the propagation calculations to determine impact radii (Table 4.4-2). This follows the protocols set forth in the NOAA Fisheries pile-driving impact calculation guidance (GARFO 2016). No other modifications in the calculations were made.

Table 4.4-2. Estimated Sound Pressure Levels Produced by a 78-inch Steel Pile Calculated for Seven Propagation Distances a/

Approximate Distance b/	Sound Pressure Levels (dB)		
	SPL	RMS	SEL
5 meters	209	194	183
10 meters	204	189	178
20 meters	199	184	173
50 meters	194	179	168
100 meters	189	174	163
500 meters	179	164	153
1,000 meters	174	159	148

Note:
a/ The source level used for the propagation calculations was reduced by 11 dB to account for the mitigative effects of an air bubble-infused coffer dam surrounding each pile.
b/ Distance measured from the pile at about mid-depth (10-15 meters deep).
Key:
dB = decibels; RMS = root mean squared; SEL = sound exposure level; SPL = sound pressure level (zero to peak)
Source: Based on Benicia-Martinez Bridge measurements from ICF Jones & Stokes and Illingworth and Rodkin, Inc. (Caltrans 2009)

Background Noise Levels

Background noise, or ambient noise, is noise that already exists in the environment prior to the introduction of another noise-producing activity. Background noise can come from a number of sources, both natural and man-made. Natural sources of ambient/background noise include biological sources (i.e., various marine species), wind, waves, rain, or naturally occurring seismic activity (i.e., earthquakes). Human-generated sources can include vessel noise (e.g., commercial shipping/container vessels), seismic air guns, and marine construction. Various factors contribute to the background noise within the proposed Project ROI. One of the major contributors to background noise would be the commercial shipping traffic near the proposed Project area associated with the Sabine-Neches Ship Channel and the Port of Lake Charles. Between the two ports, approximately 3,044 port calls for vessels >1,000 gross register tons (GRT) were made in 2012 (USDOT Maritime Administration 2012). Based on the proximity of the proposed Project area to these important shipping centers, it is expected that the background noise is dominated by large vessels (e.g., tankers, container ships) that produce source levels of 180 to 190 dB re 1 μPa rms at frequencies between 200 and 500 Hz) (Jasney et al. 2005).

Ambient noise is considered as the composite sound from both natural and anthropogenic sources within an area of interest that excludes the contributions of the sources being measured or assessed. Ambient conditions are important to consider in impact assessment as it affects the zone of audibility that an animal will have for perceiving any added sound sources. If the propagated sound level from the noise source is lower than ambient noise levels, then for this exercise it is considered that noise is not within the perceptibility of the selected animal (Kyhn et al. 2014; Wang et al. 2014).

During preliminary baseline surveys, ambient noise measurements indicated that maximum third-octave band spectral noise levels in the vicinity of the site were generally between around 115 and 150 dB re 1 $\mu Pa^2 Hz^{-1}$ with these peak band levels occurring in frequencies of a few hundred hertz, depending on time. This is fairly typical of coastal underwater noise, having higher noise levels at frequencies around a few hundred hertz and falling off at higher frequencies. The overall sampling average for the site was 118 dB re 1$\mu Pa^2 Hz^{-1}$, which was the ambient level used in our analyses. The primary anthropogenic contributors to the ambient noise level in and around the proposed LNG facility are from nearby commercial shipping lanes that pass within 50 km of the site and nearby vessels supporting existing oil and gas facilities.

Knowing the background noise of an area is important to understanding the overall impact that the introduction of more noise could have on the marine fishes. If background noise levels in the vicinity of the proposed Project exceed the NOAA Fisheries thresholds, then fish would not be affected by any sound less than the already existing dominant noise levels. For example, if the background noise levels average 150 dB, then animals would not be exposed to harassing levels of sound less than 150 dB. However, there is no current information regarding measurements of background noise in the vicinity of the proposed Project area. Therefore, it can be assumed that while vessel noise associated with the proposed Project would not add greatly to the already existing background vessel noise in the region, it cannot be assumed that the sound produced by pile driving would be completely masked by the vessel noise, especially close to the hammer. For the purposes of this evaluation, background noise levels have been assumed to be 150 dB.

Underwater Transmission Loss

To determine how noise would impact marine fishes in the proposed Project area, it is important to understand how the sound can spread away from the noise source. As the sound moves away from the source, there is a loss of acoustic intensity with increasing distance from the source. This is known as TL. It is necessary to calculate the TL of a sound source in order to determine how much area around that sound source would encompass the noise threshold criteria. How a sound travels away from a source depends on a variety of factors, including the original source level, environmental factors such as local salinity and temperature, and physical factors such as water depth, currents, and composition of bottom sediments (when depth is a limiting factor). Transmission loss also varies based on the depth of the sound source and the receiver. Considering all these components can aid in better understanding of how the sound would travel away from the source; however, it is not always possible to obtain all the information necessary to determine site-specific TL. For this analysis, TL has been set at the NOAA Fisheries default constant of 15 when using a practical spreading model. The modeling software dBSea, which incorporates environmental factors, was used in some instances as well.

Attenuation to Effects Thresholds

To determine potential impacts on fish from proposed Project pile driving, Delfin LNG determined the ensonified area surrounding the acoustic source and the ZOIs in the ensonified area that exceed the various threshold levels noted above. Based on this approach, pile driving with bubble curtain mitigation for the proposed Port is predicted to produce peak sounds above the SPL (206 dB re 1 μPa^2/sec) threshold up to 7 m, and above the lesser cSEL threshold (183 dB) up to 2,414 ft (736 m) from the source (Table 4.4-3; Figure 4.4-1). This ensonified area could result in physical injury to fishes. However, injury to non-auditory tissues in fishes with swimbladders (e.g., juvenile spot [*Leiostomus xanthurus*] and pinfish [*Lagodon rhomboids*]) cannot be assessed using SPLs. These fish are typically affected by continuous sound levels (i.e., SEL) rather than by peak noise levels. Hastings (2007) determined that an SEL as low as 183 dB (re: 1 μPa^2/sec) was sufficient to injure the non-auditory tissues of juvenile spot and pinfish having an estimated mass of 0.5 grams. Therefore, combined cSEL sound levels noted for determining effects to fish greater than and less than 2 grams (i.e., 187 dB and 183 dB, respectively) were conservatively determined to likely occur approximately 1,935 to 2,414 ft (590 to 736 m) from the sound-producing source (see Figure 4.4-1).

Table 4.4-3. Predicted Pile-Driving Noise Threshold Limits for Fish

<table>
<tr><th rowspan="4">Noise Source</th><th colspan="4">Distance to Threshold (meters)</th></tr>
<tr><th colspan="3">Onset of Physical Injury</th><th rowspan="3">Behavioral
150 dB rms</th></tr>
<tr><th rowspan="2">206
Peak (dB)</th><th>Fish ≥ 2 g</th><th>Fish < 2 g</th></tr>
<tr><th>187 dB SEL</th><th>183 dB SEL</th></tr>
<tr><td>Distance from Pile-Driving Noise Source (in meters)</td><td>7</td><td>590</td><td>736</td><td>3,981</td></tr>
</table>

Note:
a/ Assumes single strike SELs < 150 dB do not accumulate to cause injury (i.e., effective quiet).
Key:
dB = decibels
g = grams
rms = root mean square
SEL = sound exposure level

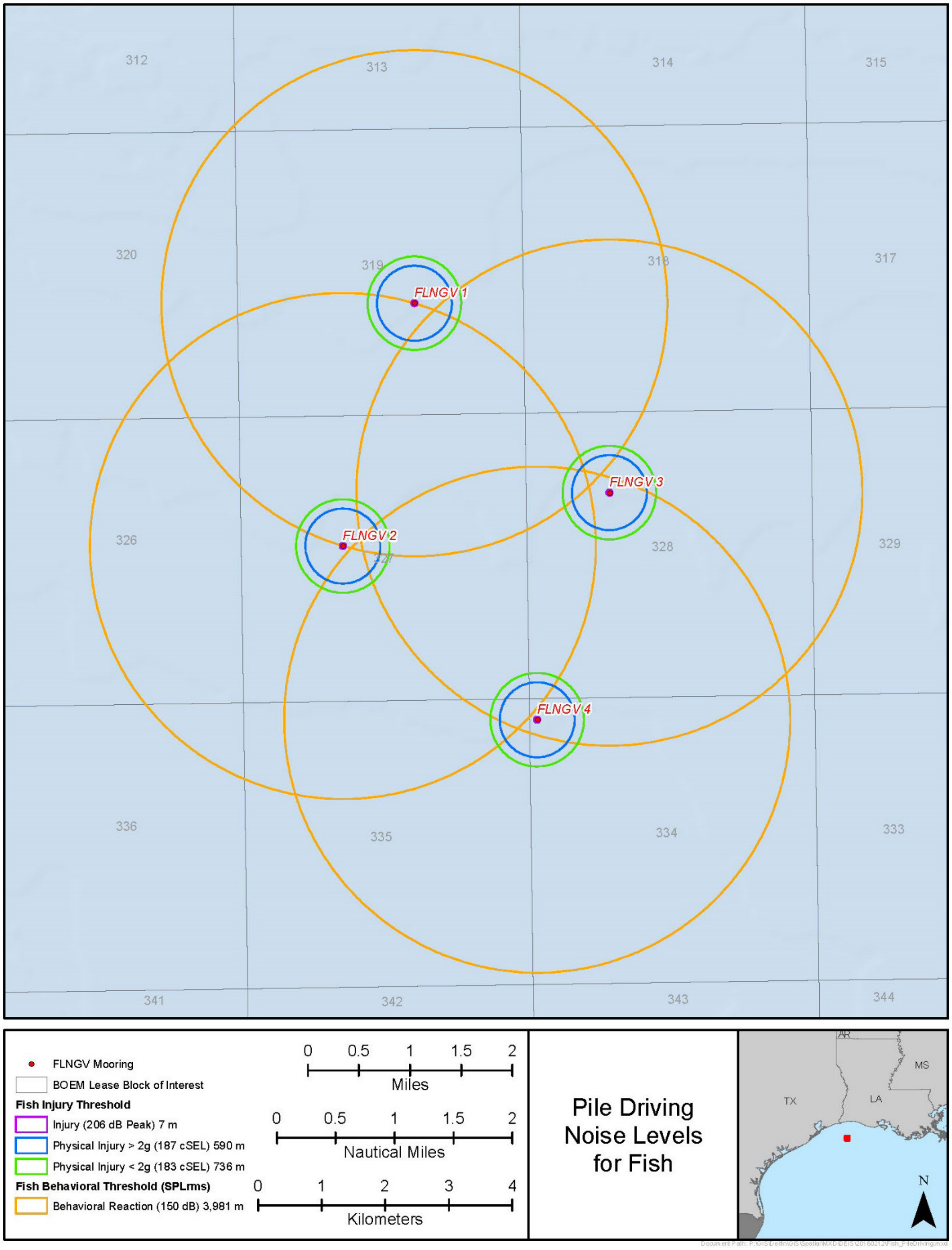


Figure 4.4-1. Pile-Driving Noise Levels for Fish

Standard acoustic criteria used for establishing acoustic impacts to fish are the GARFO (2016) guidelines. However, these criteria are only applicable to pile-driving activities for ESA-species and do not address continuous noise sources addressed in this assessment. Therefore, we used the best available information and recommended guidelines from Popper et al. (2014) to establish impact radii for fish. Because of the limited exposure and response data available for fish, Popper et al. (2014) did not assign specific threshold levels for impacts. For most fish groups, Popper et al. (2014) only provide subjective impact criteria such as "low, medium, and high" for injury risk potential of fish in zones defined as "near, intermediate and far" from the sound source. These subjective criteria, therefore, are impossible to apply in the current acoustic assessment. The only defined threshold levels for continuous noise given by Popper et al. (2014) are for fish with swim bladders that provide some hearing (pressure detection) function for the fish. Threshold levels are given for acoustic impacts resulting in recoverable injury and acoustic impacts resulting in TTS (Table 4.4-4). Popper et al. (2014) uses a 48-hour accumulation period for recoverable injury and 12-hour accumulation period for TTS. Additionally, NOAA Fisheries and the USFWS have used a SPL_{rms} of 150 dB re 1 µPa as a threshold for behavioral responses in fish (Hawkins and Popper 2014). This 150 dB re 1 µPa threshold levels has subsequently been used in the acoustic impact literature for fish although the scientific origin of this value is not known (Hasting 2008). As this threshold level has been used by regulatory entities, we have included the 150 dB re 1 µPa threshold for potential behavioral impacts.

Table 4.4-4. Threshold Levels Used To Determine the Zone of Influence Radii for Fish

Fish Category	Criteria Definition	Exposure Assessment Period	Metric	Threshold
Fish (non-descriptive)	Onset of behavioral reaction a/	12 hours	SPL_{rms}	150 dB re 1 µPa
Fish: swim bladder involved in hearing (primarily pressure detection)	Temporary Threshold Shift (TTS) b/	12 hours	SPL_{rms}	158 dB re 1 µPa
	Recoverable injury b/	48 hours	SPL_{rms}	170 dB re 1 µPa

Note:
a/ No documented scientific basis for criteria (Hastings 2008).
b/ From Popper et al. (2014) Table 7.7.
Key:
SPL_{rms} = peak sound pressure level root mean square
dB re 1 µPa = decibels relative to 1 microPascal

The isopleths corresponding to the recommended threshold levels for the fish (derived from Popper et al. 2014) were calculated using the unweighted sound field estimations modeled using dBsea acoustic modeling software (© Marshall Day) and shown in Table 4.4-5 and Figure 4.4-2. The threshold metric (SPL_{rms}) does not directly account for the exposure time during which DP operations are active in the same way. The same construction modeling scenarios as for cetaceans were used (see Section 4.3.1.3).

Table 4.4-5. Vessel Noise Impacts from Construction Activities

Scenario	Average Radial Distance in Meters to SPL_{rms} Thresholds for Fish		
	170 dB re 1 µPa for 48 hours)	TTS (158 dB re 1 µPa for 12 hours)	Onset of Behavioral Reaction (150 dB re 1 µPa for 12 hours)
Construction	590	795	1,214

Key:
SPL_{rms} = peak sound pressure level root mean square
dB re 1 µPa = decibels relative to 1 microPascal
TTS = temporary threshold shift

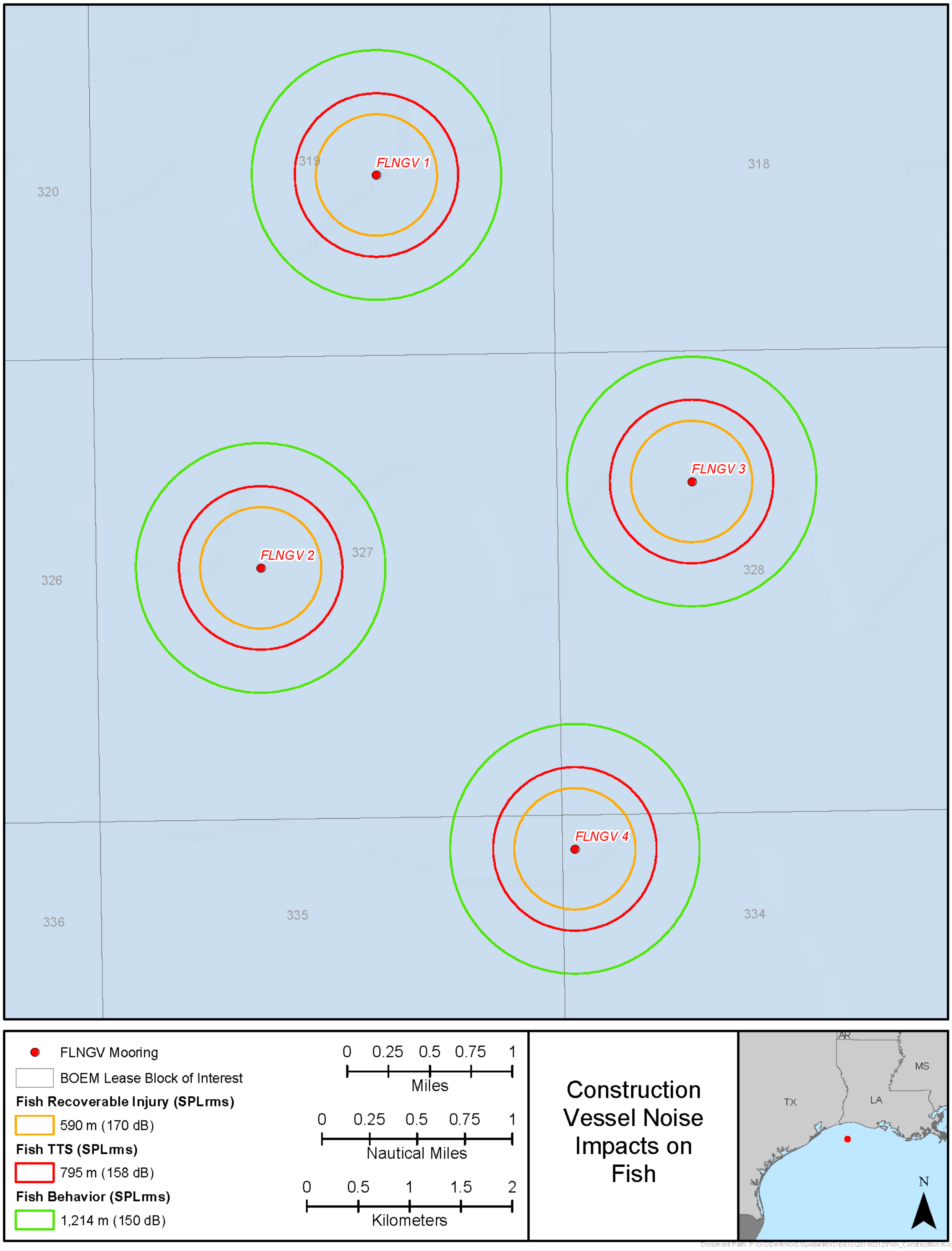


Figure 4.4-2. **Construction Vessel Noise Impacts on Fish**

Summary of Construction Noise Impacts

With the planned mitigation measures employed, physical injury (all types) to fish could potentially occur within both the SPL (see Figure 4.3-1) and SEL ZOIs (see Figure 4.4-1). Generally, for the SEL ZOI, noise could affect juveniles, small species, or benthic taxa that typically are less motile than mid-water or pelagic species. Fish within the RMS ZOI could experience behavioral effects. A small number of studies investigating the possible effects of noise, primarily seismic sound, on fish behavior have been conducted over the years. Studies looking at change in distribution are often conducted at larger spatial and temporal scales than are typical for studies that examine specific behaviors, such as startle response, alarm response, and avoidance response. The studies that examine those specific defined responses often involve caged fish rather than free-ranging fish (Hirst and Rodhouse 2000). Masking of natural/ambient sounds (e.g., communication, detection of predators and prey, gleaning of information about the surrounding environment) also has the potential to affect fish behavior.

Pile-driving activities at each TYMS would only occur for approximately one week. It is highly probable that some fish would avoid the area because of disturbing levels of sound when the impact hammer is operating; noise levels exceeding assumed “background” of 150 dB re 1 µPa rms can cause fish to avoid the immediate area around a pile being driven. However, because of the short timeframe for pile placement, it is predicted that no fish would be permanently deterred from entering the area for foraging. Also, because the area of disturbance would be small and similar habitat surrounds the site, any avoidance activity would not require extra energy expenditures. It is expected that some acoustic disturbance of fish close to an individual pile being driven, or within the immediate proposed Project area, could occur, but these impacts would be short-term and negligible, and would not be expected to result in population-level effects.

Provision of Hard-Bottom Habitat

The above-water portion of the proposed Port would provide roosting, resting, perching, and nesting surfaces that favor predators and increase the vulnerability of some fish species. The Pacific Fishery Management Council raised concerns that floating alternative energy facilities may create additional roosting sites for piscivorous birds; the Council recommended that floating structures be designed to prevent or discourage bird roosting (PFMC 2012). The assemblage of aerial predators in a given area influences the risk of predation for fish species in complex ways beyond the scope of this EFH assessment to evaluate.

Underwater portions of the proposed Port would be used as substrate for encrusting and attaching organisms, serving as the non-living framework for a biogenic reef that in turn supports a community of prey and predator species. The increased complexity of the biogenic habitat may provide enhanced refuge opportunities for small prey species, including newly recruited juvenile fishes (NOAA 2007). The presence of the proposed Port in concert with other energy infrastructure may influence local distributions of predators and prey species on a small spatial scale. Scientists and fisheries managers are engaged in an ongoing debate over whether artificial structures lead to an increase in fish abundance or simply cause existing populations to become redistributed (Shipp and Bartone 2009; Love et al. 2006; Girard et al. 2004). Apart from the argument over whether fish abundance is increased, there is little disagreement over the direct habitat value of artificial structures (NOAA 2007; GMFMC 2013). In the southeast United States, some types of artificial structures are designated as EFH, while in the Gulf of Mexico, artificial structures are expressly excluded from designation as EFH. Regardless of formal definitions, in-water portions of the proposed Project certainly provide at least temporary structural habitat to managed fishes, their prey, and their predators. On balance, the presence of the structures is considered either neutral or beneficial to most types of EFH. *As artificial habitat, the proposed Project would have no perceptible effect on populations of managed species; no particular species would be favored or disadvantaged.*

Ingestion of Marine Debris

Short-term, negligible, adverse impacts on marine fish would result from the accidental release of marine debris (e.g., ropes, plastic) during construction. Marine debris of a size that can be swallowed by a fish could be eaten either at the surface, in the water column, or at the seafloor; therefore, all six trophic guilds may be impacted. Open-ocean planktivores and piscivores are most likely to ingest materials in the water column, though. Coastal bottom-dwelling predators and estuarine bottom-dwelling predators, such as crab-eaters and benthivores, could ingest materials from the seafloor. The potential for fish to encounter and ingest marine debris depends on their feeding group, size, and geographic range. While no aspect of the proposed action includes the intentional "dumping" of debris in the marine environment, it is possible that during routine construction activities some construction-related debris could end up as marine debris.

Delfin LNG's standard operating procedures for minimizing marine debris are aligned with MARPOL 73/78 Annex V requirements and Federal regulations. Construction workers may not purposefully discard trash or debris overboard into the marine environment. To discourage illegal dumping, Federal regulations require that all equipment, tools, and containers (such as drums) be marked with permanent identification (30 CFR 250.300(c)). As required by USEPA and USCG, Delfin LNG would prepare a waste management plan and require construction workers to follow it. Best practices such as covering trash bins, sending ashore, and minimizing solid waste in general, would reduce impacts of marine debris on fisheries to negligible levels.

4.4.2 Impacts of Operation

During the operational period, maintenance of the pipeline would include pigging to periodically clean out residual materials. The release of these materials into the surrounding environment could lead to water quality impacts and contamination of adjacent benthic habitats. However, due to the expected short duration of these impacts, if they occur, no significant negative effects on EFH species' populations within the proposed Project area are expected. It is anticipated that such internal inspections would be conducted approximately once every 7 years.

As discussed in Section 4.2.1, operational discharges from the FLNGVs, including engine cooling water, ballast water exchange, wastewater, scrubber water, deck drainage, and bilge water, would comply with the applicable NPDES permit. Temperature changes, total suspended solids, and oil and grease from several sources would result in short-term changes to the marine environment in the area immediately adjacent to the discharge point.

Operational discharges from the visiting LNGCs at the proposed Port would include bilge water, wastewater, scrubber water, water curtain, deck drainage, engine cooling and other required services. LNGCs would operate under MARPOL standards, as implemented under 33 CFR 151. Temperature changes, total suspended solids, and oil and grease from several sources would result in short-term changes to the marine environment in the area very close to the discharge point.

4.4.2.1 Nonindigenous Species

Most oceangoing vessels carry marine organisms within their ballast tanks and encrusted on their hulls. However, ballast water discharge is regulated by the USCG under the National Invasive Species Act and related statues; LNGCs are not unique in carrying nonindigenous organisms. LNGCs would be required to meet CFR Title 46, Chapter I, Subchapter Q, Part 162 that addresses requirements for BWMS to be installed onboard vessels for the purpose of complying with the ballast water discharge standard of 33 CFR part 151, subparts C and D.

Compliance with USCG and international regulations on ballast water treatment and discharge would minimize the potential for introduction of nonindigenous organisms in ballast water discharge to the proposed Project area. The release of nonindigenous organisms in ballast water from LNGCs would have negligible impacts on benthic resources because LNGCs would comply with Federal ballast water treatment regulations that apply to all oceangoing vessels.

Nonindigenous species encrusted on or attached to the hulls, anchors, and other external portions of LNGCs could be released to the Gulf of Mexico. However, unintentional transport of encrusting organisms is a feature of all marine vessels. LNGCs would not pose a greater risk of transporting encrusting organisms than other similar vessels. Impacts of nonindigenous organisms transported by LNGCs on benthic resources would be negligible.

4.4.2.2 Continuous Noise

Vessel transits between the Gulf of Mexico shipping lanes and noises generated at the loading terminal are long-term sources of continuous noise associated with the proposed Project. Noise levels associated with these two activities would be relatively low and unlikely to have any effect on biological resources of the area. Peak spectral levels for individual commercial ships are in the frequency band of 10 to 50 Hz and range from 195 dB re $\mu Pa^2/Hz$ at 1 m for fast-moving (more than 20 knots) supertankers to 140 dB re $\mu Pa^2/Hz$ at 1 m for small fishing vessels (NRC 2003a). Another activity expected to produce short periods of continuous noise is LNGCs maneuvering at the terminal. Although this activity would be louder, it still would be less than the noise levels associated with large ships at cruising speed. Generally, studies (LGL 2006) have used approximately 190 dB as the expected noise level for an LNGC's thrusters. The LNGCs maneuvering using the ship's thrusters could produce short periods of louder noise (e.g., for 10 to 30 minutes every 4 to 8 days). On average, these thruster noises would be heard about 20 hours per year. Even in the unlikely event that these two activities caused disturbance to marine fish, the short periods of time involved would serve to minimize the effects.

Each FLNGV may use its electric thrusters (four azimuth thrusters at 5 megawatts [MW] each for total thrust of 20 MW) for optimum berthing angle according to conditions and Mooring Master advice. From a conservative perspective, thrusters on the FLNGV could be used for heading orientation during the mooring and unmooring evolution and possibly during loading to ease mooring line strain or improve dynamic interaction between the LNGCs and FLNGV. This would imply thruster use for approximately 8 hours each week (worst case), at 52 weeks per year. Thruster use by both the FLNGV and LNGCs would likely overlap during intermittent periods of vessels' positioning and mooring activities. In addition, Delfin LNG has committed to utilizing a minimal safe operating power that will be maintained at all times, whereby each of Delfin LNG's FLNGVs will not engage thrusters if not required to do so.

The noise impacts were estimated using the modeling approach described in Section 4.3.1.1. The isopleths corresponding to the recommended threshold levels for fish are provided in Table 4.4-6 and Figure 4.4-3. The same vessel operational modeling scenario for cetaceans (see Section 4.3.1.2) was used. The threshold metric (SPL_{rms}) does not directly account for the exposure time during which DP operations are active in the same way.

Table 4.4-6. Vessel Noise Impacts from Operational Activities

Scenario	Average Radial Distance in Meters to SPL_{rms} Thresholds for Fish		
	170 dB re 1 μPa for 48 hours	TTS (158 dB re 1 μPa for 12 hours)	Onset of behavioral reaction (150 dB re 1 μPa for 12 hours)
Construction	1,099	1,474	1,618

Key:
SPL_{rms} = peak sound pressure level root mean square
dB re 1 μPa = decibels relative to 1 microPascal
TTS = temporary threshold shift

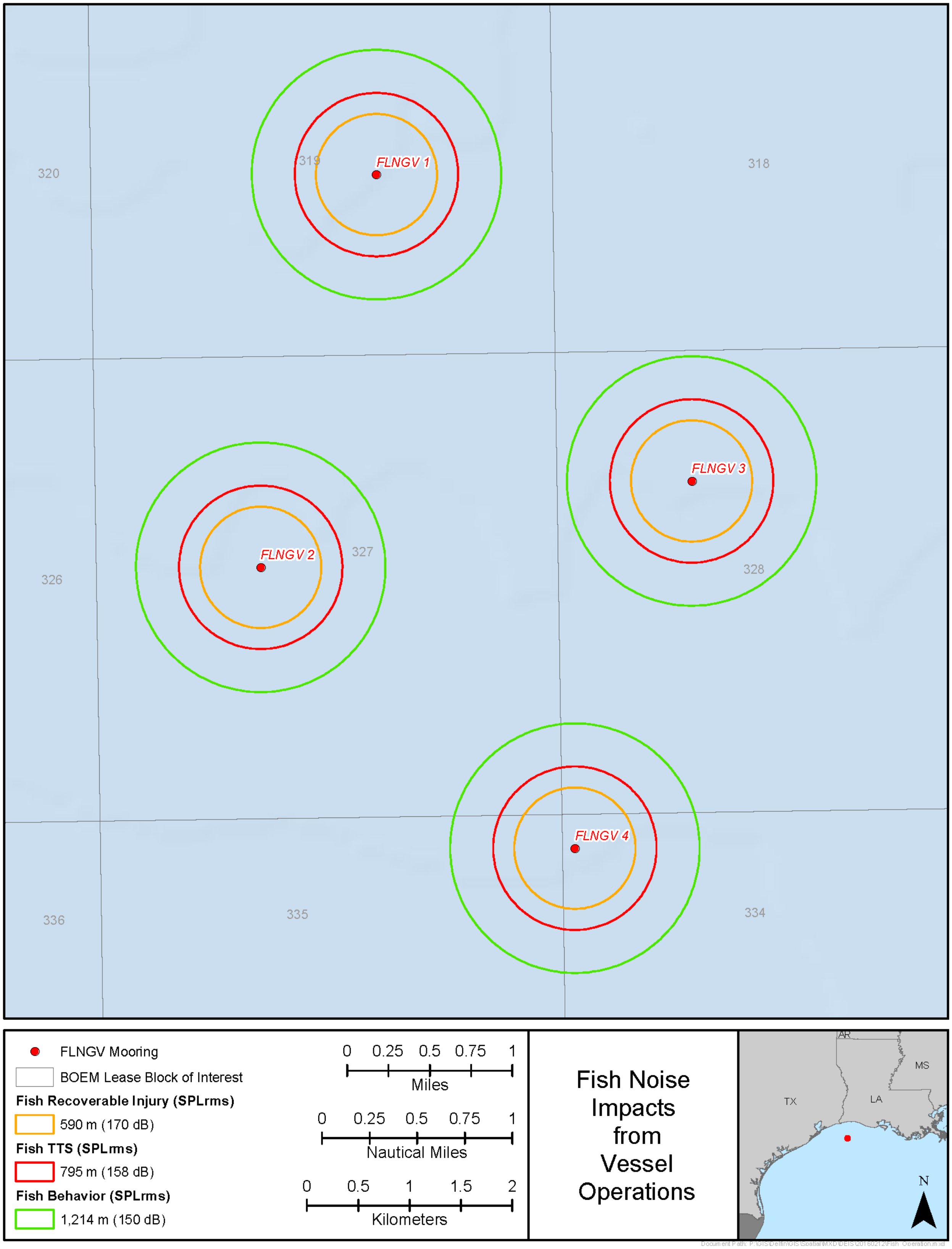


Figure 4.4-3. Fish Noise Impacts from Vessel Operations

4.4.2.3 Entrainment Impacts

Impacts from ichthyoplankton fish larvae and egg entrainment/impingement were analyzed for intake volumes associated with the proposed FLNGVs. As proposed, a single FLNGV would take in 3.0356 Mgal per day. The potential loss of equivalent age-1 fish for four target species including red drum (*Sciaenops ocellatus*), red snapper (*Lutjanus campechanus*), bay anchovy (*Anchoa mitchilli*), and Gulf menhaden (*Brevoortia patronus*) is evaluated in Appendix I.

4.4.2.4 Conclusions

Potential impacts resulting from Project construction, operation, and decommissioning are expected to be short-term and highly localized, occurring primarily during construction or shortly thereafter. Potential impacts would be minimized by siting the pipeline along a route that is devoid of complex benthic habitats or other ecologically important topographic features. Overall, impacts on managed species identified as having EFH in the proposed Project area would vary depending on the species. It is expected that species at greatest risk from various construction activities would be those with demersal life stages, where loss could be expected during trenching and other substrate-intrusive activities. In general, due to their mobility, pelagic species and those with mobile early life stages would avoid the proposed Project area during construction. Eggs and larvae that may occur within the proposed Project area would be transient, moving through the proposed Project area with the prevailing currents. Any loss of eggs and larvae during hydrostatic testing would be inconsequential to regional populations.

Short-term changes in turbidity would occur as a result of disturbance of bottom sediments during construction. These impacts would likely be highly localized and thus not be expected to be significant. Sediment disturbance along the pipeline route would also be expected to cause mortality to benthic organisms within and adjacent to the pipeline route. Direct impacts on benthic organisms would favor some predators over others temporarily but not adversely affect a species at the population level. This impact would be short-term and minor, as the community would become re-established over a relatively short period of time through immigration and recruitment. The short-term loss of the benthic community during pipeline construction would not be a significant adverse impact.

Impacts from pile driving are expected to be less than significant considering the mitigation measures proposed. If managed species are impacted, the impact would likely affect only individuals, and population-level effects would not be a concern. The short-term nature of the proposed pile-driving activities would make overall impacts not significant.

4.4.3 Impacts of Decommissioning

Impacts of decommissioning on fisheries resources would be similar on type but of shorter duration and magnitude to impacts during construction or operation, with one exception. Decommissioning would result in the loss of a large artificial reef in an area that has little to no other hard-bottom habitat.

The value of artificial habitat in supporting EFH and managed species is discussed above. The TYMS and FLNGVs are not meant to become valuable habitat for any given species, yet they may serve that function, especially because hard-bottom and topographic relief are scarce in the proposed Project area. Delfin would make decisions about decommissioning based on business needs, safety guidelines, or other factors unrelated to EFH. The physical presence of the proposed Project would have adverse or beneficial effects on various managed species. In cases where the physical structures increased the value of EFH for a given species, its removal would constitute an adverse effect, and vice versa. Therefore, the decommissioning and removal of components of the proposed Project would have a minimal adverse effect on some types of EFH, with a possible contemporaneous beneficial effect on other types of EFH.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on EFH would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.4.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.4.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on EFH.

4.4.4.2 Alternative Deepwater Port Designs

A fixed platform-based unit would destroy a larger area of soft-bottom EFH than the proposed Port, and provide a greater area of hard-bottom habitat than the TYMSs and FLNGVs. Effects on water column EFH, including ichthyoplankton and *Sargassum*, would be similar to those for the proposed Project.

4.4.4.3 Alternative Cooling Media

The Applicant considered but then eliminated the use of open-loop heat exchangers as an option due to entrainment and mortality of ichthyoplankton, impingement mortality of larger fish, and the degree of localized seawater heating caused by open-loop systems. The air-cooled system represents a reduction in seawater use of over 98 percent compared with an open-loop process cooling system, reducing the intake of seawater by millions of gallons per day.

An open loop system would result in a minor loss of ichthyoplankton by entrainment or impingement. An open-loop, water-cooled system for liquefaction utilizes a once-through water-cooling system that requires a substantial volume of seawater to remove heat from the process. Cooling water intake systems can result in both impingement mortality and entrainment mortality of aquatic organisms due to high seawater intake rates needed to meet required the volumes sufficient for liquefaction process cooling. Fish and other organisms that are pinned to intake screens are "impinged," while smaller fish, eggs, and larvae that are swept through the structure with the cooling water are "entrained." The amount of cooling seawater required depends on the acceptable temperature rise between the intake and discharge temperature (ΔT of seawater). Temperature rise in seawater can be detrimental to the local marine life if the heat cannot be dispersed by the sea currents and wave action in a reasonable amount of time. An open-loop system would use between 72 and 290 Mgal of seawater per day per FLNGV, depending on the acceptable increase of ambient seawater temperature. Secondary biological effects from the open-loop system are fish impingement on intake screens.

4.4.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on EFH associated with use of this alternative as the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.4.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). The increased depth at Alternatives 2 and 3 could require longer piles and additional pile-driving durations. This could result in additional noise impacts on EFH in the vicinity of construction activities.

4.4.4.6 Alternative Anchoring Systems

Sediment Displacement and Increased Turbidity

During installation, all anchor alternatives would have short-term turbidity and sedimentation impacts. These impacts would be limited to the duration of installation. It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in significantly less of an effect on soft-bottom EFH. Installation of a gravity-based anchor would result in the greatest disturbance of soft-bottom EFH because the footprint would be larger. The fluke anchor system would disturb a smaller area than the gravity-based anchor, but have similar adverse effects on soft-bottom EFH.

Effects on Managed Fisheries

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in significantly less of an effect on managed species. Suction anchors would adversely affect plankton, including ichthyoplankton, which the other alternatives avoid. Gravity-based anchor structures would result in a direct loss of approximately 2,500 ft^2 of soft-bottom EFH per anchor structure. However, the gravity-based anchor system structures would provide a substantial amount of hard substrate at a range of depths, leading to development of an artificial reef as described previously. Effects on managed species would be similar to those of the proposed Project.

Noise Impacts

For suction anchor and gravity-based anchors, sound generated by support vessel and barge movements and the thrusters of DP vessels would be the dominant source of underwater noise during anchor installation activities. An increase in underwater noise would be anticipated with grouted piles, mostly attributable to the use of drilling equipment. Noise impacts are expected to be greatest for driven piles due to the pulsed sounds of the hammer striking the pile. All noise impacts would be temporary for the duration of the installation.

Decommissioning Impacts

During decommissioning, driven pile and grouted pile anchors would be cut below the surface and abandoned in place. There would be a short-term and minor disturbance to surface sediments during this activity. Fluke anchors could be similarly abandoned in place with little disturbance to EFH, or backed out and recovered, resulting in short-term, minor disturbance to soft-bottom and water column EFH. Gravity-based anchors could be abandoned in place, allowing any hard-bottom communities that had become established to remain. If anchors were removed, soft-bottom and water column EFH would be affected temporarily, and the artificial hard-bottom would be lost. The suction anchor could also be abandoned in place with little disturbance to EFH, or backed out and recovered, resulting in short-term, minor disturbance to soft-bottom and water column EFH. Backing out the suction anchor, achieved by pumping seawater into the caisson to pressurize and raise the anchor, would cause entrainment of ichthyoplankton, but not to a significant degree.

Anchor Alternatives Conclusions

Given the environmental and technical considerations, the driven pile and suction anchor systems are characterized by several key advantages including a smaller footprint and decreased number of required support vessel transits during installation. Suction anchors are mostly used in a clay and fine sediment soil condition with limited stratification. Driven piles are generally used in sediment conditions consisting of more non-cohesive soil, such as sand, silt, and/or a more stratified conditions. In addition, driven piles have the ability to restrain the TYMS from large overturning events. None of the anchor alternatives would result in significant adverse effects on EFH.

4.4.5 Best Management Practices

Based on the previous analysis, there is a potential risk to managed (and other) species as a result of planned pile-driving activities for the proposed Port. To minimize impacts, Delfin LNG will institute impact minimization and mitigation measures throughout the course of the proposed Project. BMPs identified in Section 4.3 will also minimize impacts on EFH.

4.4.6 Recommendations and Conclusions

Impacts on EFH would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.4-7.

Table 4.4-7. Summary of Impacts for Essential Fish Habitat

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of mooring platforms, pipeline laterals, and WC 167 bypass	Intermittent during 5.5-year construction period	See Section 4.3.10	Negligible
Hydrostatic testing	Total of 34.0 Mgal would be discharged from the UTOS and HIOS pipelines and four proposed laterals at 2,000 gpm	See Section 4.3.10	Negligible
FLNGV and LNGC operational withdrawals and discharges	Intermittent during the 5.5-year construction period	See Section 4.3.10	Negligible

Table 4.4-7. Summary of Impacts for Essential Fish Habitat (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Vessel and aircraft noise	Intermittent during 5.5-year construction period	See Section 4.3.10	None
Anchoring	Intermittent during 5.5-year construction period	See Section 4.3.10	Negligible
Artificial lighting	Throughout 5.5-year construction period	See Section 4.3.10	Negligible
Increased vessel traffic	Intermittent during 5.5-year construction period	See Section 4.3.10	None
Marine debris	Accidental during the 5.5-year construction period	See Section 4.3.10	None
Accidental releases of fuel, oil and other chemicals	Unlikely, but possible during 5.5-year construction period	See Section 4.3.10	Short-term, minor, adverse
Operation			
Presence of terminal	During port operation	See Section 4.3.10	Short-term, negligible, beneficial
Increased vessel traffic	During port operation	See Section 4.3.10	None
Periodic pipeline maintenance	During port operation	See Section 4.3.10	Negligible
Treated water discharge	During port operation	See Section 4.3.10	Negligible
Artificial lighting	During port operation	See Section 4.3.10	None
Marine debris	Accidental during port operation	See Section 4.3.10	None
Accidental releases of fuel, oil and other chemicals	Unlikely, but could occur during port operation	See Section 4.3.10	Short-term, minor, adverse
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on essential fish habitat would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.5 Offshore Geological Resources

Activities associated with construction and operation of the proposed Project that would impact offshore geological resources include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which could disturb seafloor bathymetry and bottom sediment; and
- operational scour.

Overall geologic resources would generally not be affected by the proposed Port. Some short-term disturbance of seafloor sediments would be expected during construction and decommissioning, and negligible disturbance during operations. Impacts on seafloor geology have been avoided by physically siting the proposed Project on soft bottom sediments with no mineral leases, paleontological resources, or evidence of geologic hazards. Construction, operation, and decommissioning of the proposed Project would not be expected to impact any mineral or paleontological resources, increase the risk associated with any geological hazards (landslides, seismicity, and liquefaction), or alter sediment composition or structure to a major degree.

Generally, impacts on geologic resources or impacts caused by geologic hazards can be avoided or minimized through proper siting, foundation, and structural engineering design and construction, operation, and decommissioning techniques.

The Applicant would conduct deep geotechnical borehole sampling, testing, and analysis prior to construction in order to verify the sediment conditions and ensure that no potential hazards would be located at an anchor location or would alter the performance of the TYMS.

The sections that follow provide impact analyses for Delfin LNG's proposed site on geologic resources including sediment disturbance, bathymetry, and sediments. Protection of unique geologic features, minimization of sediment erosion, and the location of facilities in relation to mineral resources and potential geologic hazards, such as seismicity and sinkholes, were considered. The section concludes with a comparison of impacts for Delfin LNG's alternative deepwater port design, alternative cooling media, and alternative anchoring media. BMPs are also discussed.

4.5.1 Impacts of Construction

Construction of the proposed Project would have minor, short-term, direct adverse impacts on the geologic resources in the immediate area. Pipeline installation for the proposed bypass at WC 167 and the four proposed laterals would result in bottom disturbance by direct contact of anchors and pipelines. Local seafloor sediments also would be disturbed by the installation of flowlines, manifolds, umbilicals, risers, and associated service vessel moorings, which (except for the TYMS anchor setting) would have impacts on only relatively shallow penetrations and minimal spatial areas. Anchor setting would include testing of the anchor components under load and the final setting of the anchors, and may result in seafloor sediment disturbance estimated at 0.273 acre (0.11 ha) in soft sediments. This disturbance typically would be only during construction; however, the mooring structures, manifolds, risers, and other various apparatus associated with the TYMS would permanently cover areas equal to their footprint of 0.15 acre (0.06 ha).

Installation of the proposed Project pipelines would cause bottom disturbance and reduce marine environment surface area; however, this impact would be short-term and minimal. Considering the cumulative 5 miles (8 km or 26,300 ft) of pipeline trenching, and conservatively predicting a 100-ft corridor that could be affected over a short time period by deposition to some degree under the "worst-case" scenario, approximately 61 acres (24.7 ha) of geologic resources could be temporarily affected by pipeline installation. This includes 0.27 acre affected by anchoring. Approximately 0.15 acre would be permanently affected by the TYMS pilings and jackets. The suspension of sediments during these construction activities is discussed in Section 4.2.2.

The proposed Project includes the emplacement of four TYMSs with the attached FLNGVs and their associated service vessel moorings. Temporary increased turbidity and sediment displacement would occur during the installation of the TYMSs. Piling and anchor installation would be the primary components that would affect the marine environment. When installing these components, there would be permanent bottom displacement; however, the displaced area would be relatively small. Impacts as a result of TYMS installation such as resuspension of bottom sediments would be short-term and negligible. Impacts of TYMS placement would be negligible and short-term due to the rapid and efficient nature of the construction methods used. No major disturbances from construction would be expected to extend beyond the permanent footprint of the proposed Port.

4.5.1.1 Bottom Sediment Disturbance

Construction activities (installation of the proposed Project components) would result in minor short-term alterations of seafloor bathymetry and bottom sediment disturbance. Potential impacts on water quality and biological resources associated with bottom sediment disturbance are discussed in Sections 4.2 and 4.3, respectively.

4.5.1.2 Sediments

Installation of the proposed Project components would affect sediment on the seafloor. These would be confined to the construction zone and nearby areas, where disturbed sediments would resettle to the bottom. After construction, it is anticipated that currents would level any deposited sediment and return the disturbed area to approximately pre-construction conditions. Because sediment disturbance would be short-term and reversible, the adverse impacts on sediments during construction would be negligible.

4.5.2 Impacts of Operation

Potential impacts of operation of the proposed Port on geologic resources include scour and increased local turbidity. Scour, defined as the removal of granular bed material by hydrodynamic forces, could occur when the hydrodynamic bottom shear stresses are greater than the sediment critical shear stress.

Scour can cause changes in local turbidity concentrations and result in sediment disruption and movement due to changing tides and currents. Current forces in the Gulf of Mexico near the site would determine the level of the scour effect. The relatively slow tidal/current speeds and soft-bottom sediments in the northern Gulf of Mexico suggest that scour would be minimal around the weathervaning TYMS. Tropical storms and hurricanes would likely increase the amount of scour temporarily, and result in increased localized turbidity. Scour and increased turbidity would be minor, short-term, and localized.

Small-scale temporary turbidity events are common in the northern Gulf of Mexico, where tropical storms and hurricanes roil the nearshore waters. Geologic resources would not experience any lasting harm from transient turbidity fluxes.

4.5.3 Impacts of Decommissioning

Short-term direct minor adverse effects to the geologic resources near the proposed Port, which are expected in connection with decommissioning. The proposed Port is designed for a 30-year life. Decommissioning may involve the removal of all aboveground structures and leaving in place facilities below ground. The decommissioning procedure would be a reversal of the installation procedure. The proposed pipeline facilities would be decommissioned in place following termination of their service. Decommissioning of the proposed pipelines facilities would consist of purging the pipe of gas and filling it with seawater, cutting all piping at the mud line, and removing risers, platforms and associated equipment. Such activities would cause sediment displacement and the temporary increased water turbidities. It is expected that no blasting would be required for removing mooring structures during decommissioning. Typically, piles are cut at or below the ocean bottom, with infrastructure removed and transported back to shore.

Because the proposed Port would be in an area of sediment reworking, any scars related to construction, operation, or decommissioning would be expected to return to pre-construction conditions following decommissioning. Seafloor sediments would recover naturally following decommissioning. It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on geologic resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.5.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.5.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore geological resources.

4.5.4.2 Alternative Deepwater Port Designs

A fixed platform-based unit would impact a larger area of seafloor (approximately 460,000 ft^2 or 10.5 acres) than the proposed Project, thereby increasing impacts on geologic resources.

4.5.4.3 Alternative Cooling Media

The Applicant considered but then eliminated the use of open-loop heat exchangers. Any alternate cooling system identified would not impact geologic resources differently from the proposed Project.

4.5.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore geological resources associated with use of this alternative as the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.5.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Engineering at each of the alternative locations would be the same. Therefore, it could be expected that impacts on offshore geological resources from construction of the proposed Project and operation of the FLNGVs would be the same for all locations. Both Alternative 1 and Alternative 2 contain localized normal faults; however, none of the faults exhibit seafloor displacement that would preclude siting, construction, and operation of the proposed Project. A single mooring for the proposed Project and an associated service vessel mooring at Alternative 2 were located over a subsurface salt diapir. These locations would require additional evaluation of potential geophysical hazards. It is likely because of the proximity of Alternative 3 to these locations that geologic hazards would be comparable, though additional geophysical hazard analysis would need to be completed for Alternative 3 to determine specific hazards at this site.

4.5.4.6 Alternative Anchoring Systems

During installation, all anchor alternatives would have short-term turbidity and sedimentation impacts. These impacts would be limited to the duration of installation. It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on geologic resources. A gravity-based or a fluke anchor system would have greater disturbance due to a larger footprint during installation. These anchor systems would result in long-term, minor disturbance of the sea floor due to anchor sweep.

4.5.5 Best Management Practices

Delfin LNG has committed to the following BMP in addition to those BMPs identified in Section 4.2.5 regarding spill prevention and clean-up procedures:

- **BMP-24:** Delfin LNG commits to minimizing the area of subsea impact and duration of disturbance during installation and commissioning of the proposed Project. To minimize the area of subsea impact and duration of disturbance during decommissioning of the proposed Project, Delfin LNG will abandon subsea pipelines and other subsurface components more than 3 ft below mudline, and cut all bottom founded items such as driven pile and grouted pile anchors no shallower than 15 ft (approximately 5 m) below mudline to avoid exposure in the future due to storms, scouring, and other uses. Final site clearance will be verified by a trawling contractor to ensure compliance with BOEM/BSEE requirements and to ensure complete removal of infrastructure.

4.5.6 Recommendations and Conclusions

Impacts on geological resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.5-1.

Table 4.5-1. Summary of Impacts for Offshore Geological Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of pipeline laterals and WC 167 bypass	Disturbance of 61 acres for 7.5 months	BMP-24	Negligible
Construction of mooring platforms	Disturbance of 0.15 acre during 5.5-year construction period	BMP-24	Negligible
Operation			
Operational scour	During port operation	None	Short-term, minor, adverse
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on offshore geological Resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.6 Offshore Cultural Resources

This section identifies how offshore cultural resources, as described in Section 3.6, may be affected by construction and/or operation of the proposed Port and alternatives. Cultural resources include archaeological sites (prehistoric and historic; terrestrial and marine), historic standing structures, objects, districts, traditional cultural properties, and other properties that illustrate important aspects of prehistory or history or have important long-standing associations with established communities or social groups.

Activities associated with construction and operation of the proposed Project that would impact offshore cultural resources include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass which could disturb seafloor bathymetry and bottom sediment; and
- alteration of the viewshed.

The area of potential effects (APE) on archaeological resources for the proposed Port includes all marine locations that would undergo disturbance due to the proposed Project construction, operation, and decommissioning. In compliance with Section 106 of the National Historic Preservation Act (NHPA), any project, activity, or program that can result in changes in the character or use of historic properties, if any such historic properties are located in the APE. The project, activity, or program must be under the direct or indirect jurisdiction of a Federal agency, or licensed or assisted by a Federal agency. Undertakings include new and continuing projects, activities, or programs and any of their elements not previously considered under Section 106.

If the Federal agency's undertaking could affect historic properties, the agency determines the scope of appropriate identification efforts and then proceeds to identify historic properties in the area of potential effects. The agency reviews background information, consults with the SHPO/Tribal Historic Preservation Office (THPO) and others, seeks information from knowledgeable parties, and conducts additional studies as necessary.

In letters dated January 4, 2016, the USCG initiated consultation with the Louisiana and Texas SHPOs. The letters briefly described the proposed Project and included a map showing the proposed Project location. The letter explained that the USCG and MARAD are preparing an EIS as part of the environmental review of the Delfin LNG deepwater port license application and asked if the SHPOs had any concerns regarding potential effects of the proposed Project construction or operation on cultural resources that may be listed in or eligible for the NRHP. Copies of agency correspondence, including these letters, are included in Appendix D.

On September 11, 2015, the Choctaw Nation of Oklahoma requested Consulting Party status for the proposed Project. The tribe noted an interest particularly in ground-disturbing activity onshore and requested a copy of the EIS. USCG consulted the following Native American Tribes by letters dated January 4, 2016: Alabama Coushatta Tribe of Texas, Choctaw Nation of Oklahoma, Coushatta Tribe of Louisiana, Jena Band of Choctaw Indians, Mississippi Band of Choctaw Indians, and the Tunica-Biloxi Tribe of Louisiana. On January 12, 2016, the Quapaw Tribe of Oklahoma declined the opportunity to comment on the proposed Project as it would be located outside of the current area of interest for the tribe. On February 17, 2016, the Jena Band of Choctaw Indians provided concurrence with a determination of No Effect to Historic Properties. On February 22, 2016, the Choctaw Nation of Oklahoma requested additional information on the location of the proposed Project and any planned cultural resources investigations. Copies of agency correspondence, including these letters, are included in Appendix D.

Impacts on cultural resources are considered to be major if proposed Project construction, operation, or decommissioning would cause an irreversible adverse effect to the characteristics that contribute to the eligibility of a property for the NRHP. Under Federal regulations, adverse effects may include, but are not limited to:

- physical destruction of or damage to all or part of the resource;
- a change in character of the property's use or physical features within a property's setting that contribute to its historic significance; and
- introduction of visual, atmospheric, or audible elements that diminish the integrity of the property's significant historic features.

4.6.1 Impacts of Construction

There is potential to impact submerged cultural resources in the APE as a result of construction of the proposed Project. Archaeological survey reports for the proposed Project have been reviewed by MARAD, the Louisiana SHPO, and the Texas SHPO. Magnetic anomalies, sidescan sonar targets, and subbottom profiler images have been identified that reveal the locations of submerged potential cultural resources. No areas with high potential to contain submerged buried archaeological sites were identified.

Archaeological review of the geophysical and geotechnical data collected within the terminal area of the proposed Project APE revealed three recorded magnetic anomalies that corresponded to sonar contacts in the terminal survey area. Each varies in size and each displays no relief off the sea floor, suggesting potential for archaeological origin. Additionally, three sonar contacts and two magnetic anomalies recorded within the bypass channel survey area of the APE may represent respectively: a portion of a shipwreck debris field; a small vessel; and other unidentified cultural resources. Any of these potential cultural resources may meet the criteria to be eligible for the NRHP.

Delfin LNG has determined that it would avoid impacts on these potential cultural resources and has assigned a ZA to each location. Implementation of the ZAs would result in avoidance of disturbance to the respective potential cultural resources. In the absence of currently established standards for the creation of a ZA for the protection of submerged cultural resources, the defined ZAs take into consideration the areal extent of the remains, the environmental conditions in which the resources are located, and the nature of the proposed Project activity. In addition, the water depth, currents, surface energy, and sediment type are also considered determining factors in defining the ZA for these potential cultural resources.

4.6.2 Impacts of Operation

There would be no direct or indirect impacts on cultural resources from the operation of the proposed Project because no new areas of seafloor would be impacted by operational activities. The FLNGV would appear from onshore receptors as a large vessel on the horizon, similar to those visible in the current viewshed.

4.6.3 Impacts of Decommissioning

No impacts on submerged cultural resources would be expected as a result of the decommissioning of the proposed Project provided that anchor handling plans and avoidance plans are implemented to avoid all noted high probability targets and shipwrecks.

4.6.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.6.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the

Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore cultural resources.

4.6.4.2 Alternative Deepwater Port Designs

The fixed platform-based unit alternative design consists of constructing or re-purposing an offshore unit, which is either an active or decommissioned facility. This alternative may result in effects to submerged potential cultural resources that would be more widespread than those resulting from the proposed FLNGV. The fixed platform-based unit may also have some associated visual impacts on onshore receptors.

4.6.4.3 Alternative Cooling Media

Two alternative cooling media are considered for the proposed Project. Neither the open-loop, water-cooled heat exchangers nor the air-cooled heat exchangers would result in effects to potential cultural resources.

4.6.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore cultural resources associated with use of this alternative as the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.6.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Engineering at each of the alternative locations would be the same. Therefore, it could be expected that impacts on offshore cultural resources from construction of the proposed Project and operation of the FLNGVs would be the same for all locations. The Applicant conducted a cultural resources assessment of remote-sensing data and it was determined that neither Alternative 1 nor Alternative 2 are within 1,000 ft of potentially significant cultural resources in accordance with BOEM guidelines (NTL No. 2005-G07). Surveys were not conducted to determine the potential for cultural resources in proximity to Alternative 3.

4.6.4.6 Alternative Anchoring Systems

Five anchoring systems were considered for the proposed Project. Four of these—suction anchors, driven piles, fluke anchors, and grouted pile anchors—involve installation of sub-seafloor anchoring that could result in potential effects to submerged cultural resources. The fifth system, gravity-based anchors, is not likely to result in effects to submerged cultural resources; however, it is not an effective system for the proposed Project for reasons other than cultural resources issues. The locations of anchors have been determined to avoid potential effects to identified potential submerged cultural resources.

4.6.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-25:** If the proposed Project cannot avoid targets identified as potentially significant cultural resources, then further investigations will be required to determine if these targets represent potential historic properties. If the targets are identified as historic properties, an appropriate treatment plan will need to be developed and implemented prior to construction.
- **BMP-26:** Delfin LNG has developed an *Unanticipated Discoveries Plan* for the offshore components of the proposed Project (Appendix J). This plan will be reviewed by the Louisiana SHPO, Texas SHPO, and BOEM. All proposed Project construction, operation, and decommissioning personnel shall be familiar with the plan and the steps that Delfin LNG has agreed to follow in the event of the discovery of a significant cultural resource including human remains.
- **BMP-27:** Delfin LNG commits to the ZA with respect to the magnetic anomalies at the proposed Port site and the positive sonar contacts at the proposed WC 167 bypass to avoid impacts on cultural resources during the installation and decommissioning phases of the proposed Port.

4.6.6 Recommendations and Conclusions

Impacts on cultural resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.6-1.

Table 4.6-1. Summary of Impacts for Offshore Cultural Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of pipeline laterals and WC 167 bypass	Disturbance of 61 acres for 7.5 months	BMP-25; BMP-26; BMP-27	Negligible
Construction of mooring platforms	Disturbance of 0.15 acres during 5.5-year construction period	BMP-25; BMP-26; BMP-27	Negligible
Operation			
Viewshed disturbance	During Port operation	None	Negligible
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on offshore cultural resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.7 Ocean Use, Offshore Recreation, and Offshore Visual Resources

Activities associated with construction and operation of the proposed Project that would impact ocean use, recreation, and visual resources include the following:

- construction and presence of the proposed mooring platforms, pipeline laterals, and WC 167 bypass;
- increased vessel traffic;
- presence of Safety Zones;
- presence of TYMS; and
- accidental releases of fuel, oil, and other chemicals during construction and operations.

Ocean use, recreation, and visual resources impacts could result during construction, operation, and decommissioning of the proposed Port. Activities that would impact these resources include increased vessel traffic; a Safety Zone, NAA, and ATBA; increased turbidity; and the visual presence of proposed Port infrastructure.

4.7.1 Ocean Uses

The many offshore activities that are known to occur with frequency in the proposed Project area would all continue to occur with minimal impact from the proposed Project during any phase (construction, operations, maintenance, or decommissioning). This statement is made primarily due to the fact that the proposed Project is making use of existing infrastructure for the majority of its operation as opposed to a traditional "greenfield" construction operation. The locations within the proposed Project area that would see traditional offshore construction are discrete and located at coordinates strategically designed to allow other maritime stakeholders to continue their normal activities unencumbered by strict proximity limitations.

4.7.1.1 Impacts of Construction

Since the proposed Port leverages existing seabed assets for much of its physical presence on the seabed, the impacts of construction on other ocean uses would be negligible. In the two locations where more traditional construction operations would occur (those being the proposed bypass at WC 167 and the proposed facilities in and around WC block 327), impacts would remain negligible with respect to mercantile shipping, a crucial Louisiana industry centered in the Mississippi delta. Neither construction location is located within any of the established navigation fairways, and the fairways in and around the proposed Project do not generally serve the main ports of the Mississippi delta. Even vessels bound for southwest Louisiana ports should not be impacted to any major degree by construction or operation.

Since construction operations occur in lease blocks that Delfin LNG controls via lease or existing agreement, ongoing petroleum operations in and around the proposed Project area would proceed unfettered as well. Standard maritime communications should allow each individual entity operating in or around the proposed Project area to operate efficiently throughout the construction period. Major vessel and floating facility mobilizations and demobilizations occur within the petroleum industry as a matter of course and no offshore mariners are better prepared for offshore coordination than those operating in the Gulf of Mexico.

No major impacts would be expected within the commercial or recreational fishing sectors due to construction either. The proposed Project area is not an area that is highly valued by the recreational fleet, and any and all displacement that may occur would simply shift recreational fishing effort to similar locations located near the construction operations. The same may be said of commercial fishing operations. While it has been published that commercial red snapper fishing out of Galveston (by baited multi-hook lines on electric or hydraulic bandit reels) does occur in shipping fairways and in and around petroleum facilities, these operations would also have the ability to shift slightly away from the discrete construction operations to continue their normal operations if they need to.

One sector of the commercial fishing industry that would be displaced from establishment of ATBAs for the life of the proposed Project is commercial otter trawlers. These vessels target benthic species and the most popular quarry in this industry is shrimp. The Gulf of Mexico commercial shrimp trawling industry employs approximately 4,950 individuals and operates from the estuarine environments along the coastline to the deep boundaries of the continental slope depending on which species is targeted (NOAA Fisheries 2012b). It is very difficult to discern how often trawlers operate within the ATBA of the proposed Project area but it is not assumed to be an area of high activity. This assumption is based upon the existing seabed infrastructure within these active lease blocks. Surface-laid petroleum infrastructure, for example, could snag a shrimp trawl net destroying it or causing the fisherman to abandon it entirely. The total acreage that would be lost to commercial trawling within and between the ATBAs is approximately 10,784 acres.[28]

Recreational activities in and around the proposed Project area are very limited due to the dearth of the required facilities to support recreational vessels in southwest Louisiana. Activities such as wildlife viewing, diving and recreational angling are centered in other parts of the Gulf coast. The few recreational vessels that may be impacted by construction operations can shift their destinations or transit corridors slightly to avoid construction activity while remaining in very similar waters.

4.7.1.2 Impacts of Operations

Once operational, the impacts of the proposed Port on all critical ocean uses would be reduced. The sporadic use of the offshore facilities would likely lessen large vessel traffic through the established fairways rather than increase it. This is because port calls made by natural gas vessels may be rendered as less of a necessity once the proposed Port is operational. This leaves a higher capacity within existing channels for other vessels continue or even expand into diverse operations.

When vessels do make use of the facility, they would remain outside of the fairways allowing traditional or increased ship traffic to continue their safe passage. Commercial fishing vessels traversing in and out of Galveston, Texas, would see no interruptions to access of their home port facilities. Other existing petroleum activities would not occur within the blocks where Delfin LNG is operating; therefore, they should proceed as normal, with perhaps some level of increased coordination with respect to safe, simultaneous vessel movements.

4.7.1.3 Impacts of Decommissioning

The impacts of decommissioning this facility would be comparable or slightly less impactful than those associated with the limited, traditional construction operations.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on ocean uses would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.7.2 Recreation Resources

Recreation resources such as fishing and offshore sports could be impacted by the proposed Project; however, the dearth of such activity in southwest Louisiana renders any potential impact negligible. Two hundred nautical miles east, in and around the Mississippi delta, marine tourism and recreation is a critical part of the economy. Between eco-tours of the delta and the adjacent coastal region and river cruises in and around the tourist center that is New Orleans, such activity is a major piece of the local tourism and

[28] This number was generated based on an estimation of the entire area that would be lost to commercial trawling due to establishment of the ATBAs; however, it should be noted that this is larger than the individual ATBA acreages as it encompasses the area in between the four unique ATBAs.

recreational economy. Conversely, as a region, southwest Louisiana has no real maritime ports that might serve as a hub of such activity and therefore it is not a key piece of the local economy. Any impacts would result from a decrease of open water areas available to the public and potential interference of recreational activities with proposed Project-associated vessel traffic and activities.

4.7.2.1 Impacts of Construction

Negligible impacts on recreational fishing and other activities, including boating and scuba diving, would result from construction of the proposed Port due to the presence of exclusion zones, increased vessel traffic, and impacts on water quality that would adversely impact fish and marine life. Impacts on water quality resources and biological resources are discussed in Sections 4.2 and 4.3.

4.7.2.2 Impacts of Operations

Negligible impacts on recreational fishing and other activities including boating and scuba diving, would result from operation of the proposed Port due to the presence of exclusion zones and increased vessel traffic. The proposed Safety Zone and NAA would restrict access of the area and impact recreational activities for the life of the proposed Port's operation. The ATBA would be noted on navigational charts and Notices to Mariners, but would not restrict entry of recreational vessels. The possibility of fishing equipment being snagged by pipelines would present a potential impact on fishing activities near the proposed Port. In comparison to the large available area of recreational resources in the northern Gulf of Mexico, off the coasts of Louisiana and Texas, the long-term adverse impacts on recreational resources would be negligible.

Details on impingement and entrainment of plankton resources, including ichthyoplankton, and the impact this would have on biological resources that may attract recreational fishers are provided in Section 4.3.7.

4.7.2.3 Impacts of Decommissioning

Impacts during decommissioning would be similar to those experienced during construction; however, decommissioning is expected to take approximately 10 weeks to complete. A short-term increase in turbidity would result in a temporary decrease in water quality and corresponding adverse impacts on the limited recreational activities in the proposed Project area. These impacts would cease after decommissioning was complete.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on recreational resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.7.3 Visual Resources

The proposed Port would be located approximately 37.4 to 40.8 nautical miles from the Louisiana shore and the proposed pipeline bypass location would be approximately 24.7 to 28.4 nautical miles offshore; therefore, neither of these sites would be visible from shore. The baseline visual character in the proposed Project vicinity is open ocean with oil and gas platforms, drilling rigs, and aids to navigation. There are no designated scenic areas or scenic resources near the proposed Port or bypass location. Potential viewers would be limited to work crew members, oil and gas operators, ships, and individuals participating in offshore recreational or commercial activities in the area.

4.7.3.1 Impacts of Construction

Short-term, minor, adverse impacts on visual resources would result from construction of the proposed Port. Short-term visual impacts would be caused by construction and support vessels traversing to and from the shore base and onshore fabrication site to the proposed Port and proposed bypass location. The offshore construction activity would take place beyond the range of sight from onshore locations.

4.7.3.2 Impacts of Operations

The design and configuration, including final color schemes, of the proposed FLNGVs and TYMS would be determined as part of Front End Engineering Design. Delfin LNG's presence is the use of neutral colors; however, regardless of color, the location of the proposed FLNGVs and TYMS more than 37 nautical miles offshore results in no visibility from the shore. Long-term, minor, adverse impacts on visual resources would result from operation of the proposed Port. Supply ships transporting materials from onshore facilities to the proposed Port would be minor impact disrupting the viewscape; however, it is assumed that the residents of the area are accustomed to seeing offshore service vessels transit the nearshore and offshore waters. Operational impacts would be considered minor due to the in-kind alteration to the existing industrial viewscape and the limited number of potential viewers.

4.7.3.3 Impacts of Decommissioning

Short-term, minor, adverse impacts on visual resources would result from decommissioning of the proposed Port. Short-term visual impacts would be caused by construction and support vessels traversing to and from the shore base to the proposed Port location. The decommissioning phase is expected to last approximately 10 weeks and would result in the elimination of the proposed Port from the permanent viewscape.

It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on visual resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.7.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.7.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on ocean use, offshore recreational resources, or offshore visual resources.

4.7.4.2 Alternative Deepwater Port Design

Greater seabed disturbance would be expected if a fixed platform-based unit was used, and this may result in some additional impact on ocean use and recreational resources including fishing; however, impacts would likely still be minor due to the existing ocean use in the proposed Project area.

The platform-based design would result in greater impacts on visual resources than use of an FLNGV; however, due to the distance of the proposed Port from the coast of Louisiana in combination with the existing visual landscape which consists of oil and gas infrastructure, impacts on visual resources would not be a concern to onshore receptors for any of the proposed Port design alternatives.

4.7.4.3 Alternative Cooling Media

Use of alternative cooling media would have no differentiated impact on recreation or visual resources.

Use of an open-loop, water-cooled system would result in higher levels of impingement and entrainment mortality and additional impacts on marine life at the point of discharge due to temperature rise. This would likely result in additional impacts on recreational and commercial fishing activities in the immediate proposed Port vicinity; however, given that fishing activity is limited in this area, impacts would be minor.

4.7.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC would not require any greenfield construction; therefore, there would be slightly reduced impacts on ocean use, offshore recreation, and offshore visual resources associated with use of this alternative as the extent of construction would be reduced. Impacts on these resources during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.7.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). All alternative locations would be far enough from shore to reduce visual impacts, a comparable distance from the closest maritime safety fairway, and none of the areas are in a Military Warning Area. Though the closest oil and gas platform for Alternative 1 (4.1 miles) and Alternative 3 (5.4 miles) is closer than the closest platform for Alternative 2 (7.1 miles), the platforms are unmanned, meaning there is limited transit of support vessels and traffic to and from the platforms. In addition, neither alternative location contains an active OCS lease block within 5 miles. Therefore, impacts on marine uses and aesthetics would be similar at both Alternative 1 and Alternative 2.

4.7.4.6 Alternative Anchoring Systems

Use of an alternative anchoring system would have no differentiated impact on recreational or visual resources.

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on commercial and recreational fishing. Suction anchors, by virtue of pumping out water from inside the caisson would have an impact on the zooplankton within that water column, which the other alternatives avoid. Gravity-based anchor structures would result in a direct loss of existing fish habitat in approximately 2,500 ft^2 per anchor structure. However, the gravity-based anchor system structures would provide hard substrate at different depth which would likely result in an artificial reef sustaining development of new biotic communities that have a potential to support marine populations. Such gravity-based anchor reefs would not be available to commercial and recreational fishermen so would not result in any direct positive economic impact. Although selection of an alternative anchoring system may result in additional impacts on commercial and recreational fishing, the minimal level of fishing activity in the proposed Project area would limit any additional impact.

4.7.5 Best Management Practices

In addition to the navigational aids discussed in Section 4.8.5, Delfin LNG has committed to the following BMPs specifically related to ocean use, recreation, and visual resources:

- **BMP-28:** Siting the proposed Port in a location with limited oil and gas activity and without unique fishing or recreational properties or significant sediment resources will minimize impacts on ocean uses and marine traffic.
- **BMP-29:** Siting the proposed Port more than 37 nautical miles from the Louisiana shore will prevent land-based viewers from having their viewshed impaired by the proposed Project.

4.7.6 Recommendations and Conclusions

Impacts on ocean use, offshore recreation, and offshore visual resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.7-1.

Table 4.7-1. Summary of Impacts for Ocean Use, Recreation, and Visual Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of pipeline laterals and WC 167 bypass	During 7.5-month construction period	BMP-28	Negligible
Construction of mooring platforms	Intermittent during 5.5-year construction period	BMP-28	Negligible
Increased vessel traffic	During 5.5-year construction period	BMP-28	Negligible
Accidental releases of fuel, oil, and other chemicals	Unlikely, but could occur during port construction	BMP-28	Negligible
Operation			
Presence of Safety Zones	Permanent during port operation	BMP-28	Negligible
Presence of TYMS	Permanent during port operation	BMP-28; BMP-29	Negligible
Increased vessel traffic	Intermittent during port operation	BMP-28	Negligible
Accidental releases of fuel, oil, and other chemicals	Unlikely, but could occur during port operation	BMP-28	Negligible
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on ocean use, recreation, and visual resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.8 Offshore Transportation

Activities associated with construction and operation of the proposed Project that would impact offshore transportation include the following:

- increased vessel traffic.

As described in Section 3.8, offshore transportation in and around the proposed Project area consists of commercial and recreational boating traffic, commercial shipping traffic, including commercial vessel traffic in the Sabine Pass Safety Fairway. Potential impacts resulting from increased vessel traffic are expected to be effectively avoided by maintaining safe navigation practices established through the 1972 International Rules of the Road (Convention on the International Regulations for Preventing Collisions at Sea, 1972 [72 COLREGS]).

4.8.1 Impacts of Construction

Impacts on offshore transportation from proposed Port construction would be short-term, minor, and adverse. Commercial and recreational vessels would be excluded from the construction area during the construction phase of the proposed Port. Construction of the proposed Port would increase vessel traffic within the proposed Port area, but not to a major degree over the current number of vessels operating in the proposed Port. Vessels involved with construction of the proposed Project, which would include derrick barges, support tugs, diver support vessels, supply vessels, and crew/survey vessels, would generally operate at slow speeds relative to other vessel traffic in the proposed Port. Potential impacts resulting from installation of the proposed laterals from the existing HIOS pipeline and the proposed WC 167 bypass and construction vessel transits through the Sabine Pass Safety Fairway are expected to be effectively avoided by maintaining safe navigation practices established through the 72 COLREGS.

4.8.2 Impacts of Operation

Operational impacts on offshore transportation would be long-term, minor, direct, and adverse.

The Safety Zone, NAAs, and the ATBA, described in Section 2.2.10.1, would restrict non-Project-related vessels (see Section 5.5.2). During operation, vessels would be precluded from transiting through the Safety Zone. Surrounding these areas, the proposed Port would not impact offshore transportation. LNG would be loaded onto the LNGCs from each of the four FLNGVs. These LNGCs would travel through open waters at a speed of approximately 20 knots, inbound within the Sabine Pass Safety Fairway. A Mooring Master would board the approaching LNGCs approximately 8 to10 nautical miles from the safety zone to provide navigational and maneuvering advice to the LNGC master. Approach direction and berthing maneuvers would depend on the prevailing wind and sea conditions, vessel maneuvering characteristics, and other factors as determined on location by the LNGC Master in consultation with the Mooring Master. The LNGCs would depart outbound in the Sabine Pass Safety Fairway, assisted by Delfin LNG's dedicated tugs. Potential impacts on the use of the Safety Fairway are expected to be effectively avoided by maintaining safe navigation practices and not interfering with existing vessel traffic patterns. LNGCs are expected to call at each of the four FLNGVs on a schedule designed to allow for continuous production of LNG (accounting for expected maintenance and downtime). It is anticipated that there would be an estimated 120 offtakes per year; on average, one LNGC would be arriving while another is departing within each 3-day window. As currently planned, Delfin LNG does not anticipate simultaneous arrival and departure operations such that LNGC traffic is minimized and only one arrival/departure event is schedule for the same time period. Maintenance and repair activities would require the deployment of a diver-support vessel for minor repairs or vessels similar to those used for construction for major repairs. Planned and unplanned maintenance and repair activities would cause a short-term and negligible increase of vessel traffic in the proposed Port, similar to traffic described for construction.

Figure 4.8-1 shows the typical routes of the LNGCs into and out of the proposed Port.

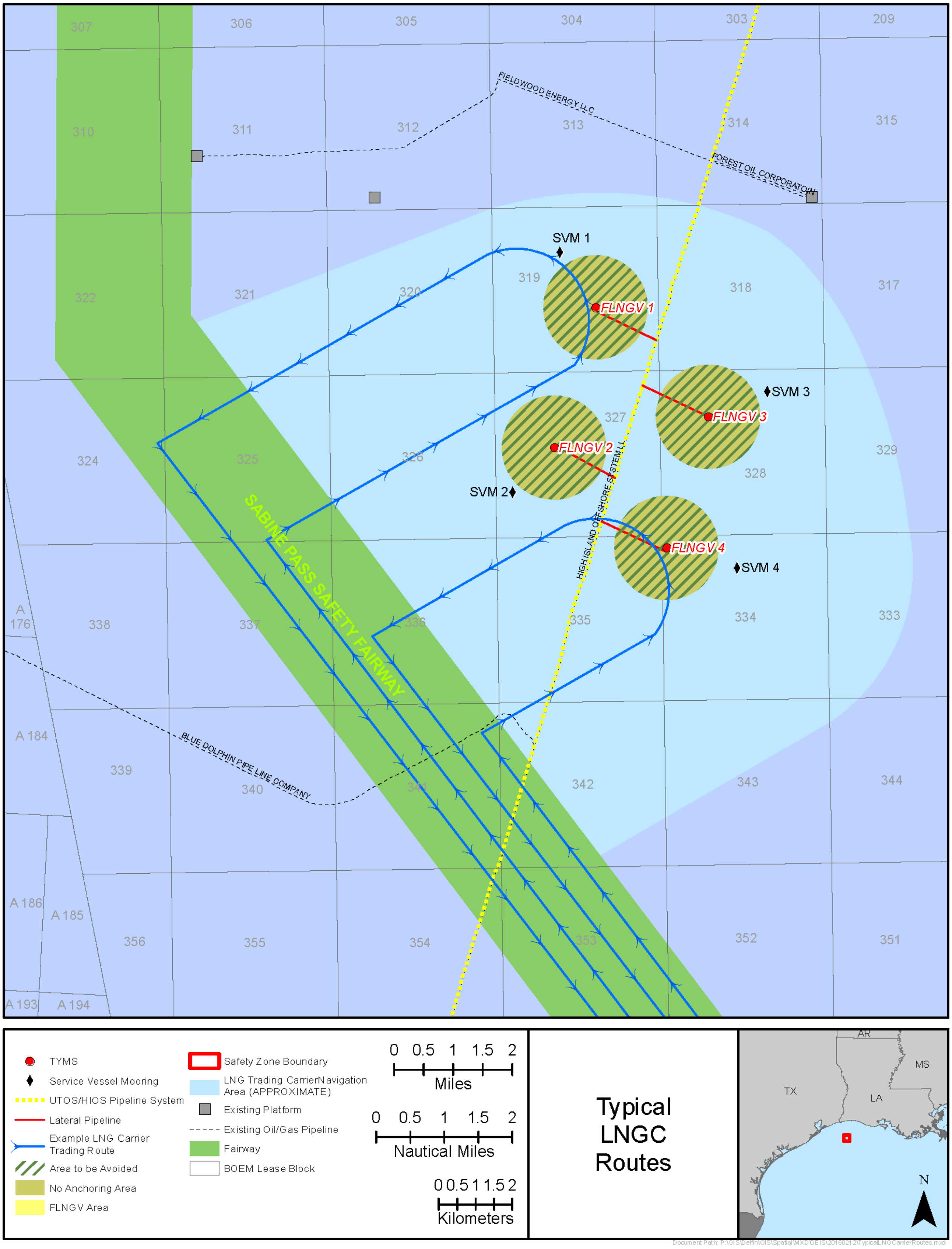


Figure 4.8-1. Typical LNGC Routes

4.8.3 Impacts of Decommissioning

Decommissioning of the offshore components of the proposed Project would involve abandoning or removing the proposed Port facilities and abandoning the proposed existing UTOS/HIOS pipeline system and pipeline laterals in-place to be consistent with current Federal policies to minimize adverse impacts, and would have similar but less intensive impacts as that of construction. It is expected the proposed Port would be in operation for at least 30 years. Potential transportation impacts would be reassessed prior to decommissioning based on conditions and regulations at that time.

4.8.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, anchoring systems, DOF locations, and compressor station designs were evaluated. A No Action Alternative was also evaluated.

4.8.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore transportation.

4.8.4.2 Alternative Port Design

Gravity-based structures would require construction and support vessels with special capabilities to prepare the seabed. Although the characteristics of these vessels have not been specified, the location of the construction site is far enough from the safety fairways that it is not expected to have substantially different impacts on marine transportation. A fixed platform-based unit would require construction vessels with the capability to lift and assemble components that have been fabricated ashore. Again, the location of the construction site is far enough from the safety fairways that it is not expected to have substantially different impacts on marine transportation. The floating HiLoad port and FLNGV would have similar impacts on transportation. These two vessels would be constructed elsewhere and towed, in the case of the HiLoad design, or delivered under its own propulsion, in the case of the FLNGV. It is expected that these two design alternatives would result in less impact on marine transportation than other alternative designs because the mooring system is expected to require fewer construction vessel transits.

4.8.4.3 Alternative Cooling Media

Use of alternative cooling media would have no differentiated impact on marine transportation.

4.8.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC would not require any greenfield construction; therefore, there would be slightly reduced impacts on transportation associated with use of this alternative as the extent of construction would be reduced. Impacts on transportation during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.8.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Engineering at each of the alternative locations would be the same; however, because Alternatives 2 and 3 are 10 to 15 nautical miles farther offshore from Alternative 1, it is likely that minor additional impacts on transportation would result. Alternative 1 is about 3.0 nautical miles from the Sabine Pass Safety Fairway, whereas Alternative 2 is about 2.3 nautical miles from the Sabine Pass Safety Fairway, and Alternative 3 is about 2.3 nautical miles from the Calcasieu Pass Safety Fairway.

4.8.4.6 Alternative Anchoring Systems

The impacts on marine transportation from the use of the various alternative anchoring systems (suction anchors, driven piles, fluke anchors, gravity-based anchors, or grouted pile anchors) would differ to a small degree, mainly as a result of the type of construction vessels required for each type. For example, fluke anchors would require anchor-handling tugs and a deck barge whereas gravity-based anchors, suction anchors, driven piles, and grouted pile anchors would require a construction barge capable of positioning and installation. Fluke anchors would likely require somewhat less installation time (and support vessel transits) than any other alternative system; however, these anchors would be more likely to require subsequent repositioning the other alternatives.

4.8.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-30:** The Delfin LNG Port Operations Manual (Appendix K) outlines the procedures and mitigation measures that will be in place for the proposed Port, including establishment of Safety Zones, ATBAs, and NAAs around each FLNGV (see Section 5), as well as other navigational aids.
- **BMP-31:** If required by USCG, Delfin LNG will have selected construction and installation vessels make periodic very high frequency radio broadcasts advising nearby mariners of construction activities and the presence of any temporary safety zones.
- **BMP-32:** Delfin LNG will communicate with the USCG, USACE, and Federal and State pilots in the region (Lake Charles Pilots Association and Sabine Pilots) to provide information concerning proposed Project construction and installation activities.
- **BMP-33:** Notice to Mariners will be issued to provide wide notice of the temporary safety zone established during installation and commissioning of the proposed Project.

4.8.6 Recommendations and Conclusions

Impacts on transportation would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.8-1.

Table 4.8-1. Summary of Impacts for Offshore Transportation

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Increased vessel traffic	Intermittent impacts during the 5.5-year construction period	BMP-30; BMP-31; BMP-32; BMP-33	Minor, short-term, adverse
Operation			
Increased vessel traffic	Intermittent throughout operation	BMP-30	Negligible
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on off-shore transportation would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.9 Offshore Air Quality

Activities associated with construction and operation of the offshore components of the proposed Project that would impact air quality include the following:

- construction of the proposed mooring platforms, pipeline laterals, and WC 167 bypass;
- initial startup and commissioning of the FLNGVs;
- first-year liquefaction train restart events of the four FLNGVs;
- liquefaction train restart events of the four FLNGVs;
- routine operational emissions;
- heavy weather operations; and
- mobile source operations.

4.9.1 Impacts of Construction

Construction activities would produce air emissions, predominantly combustion emissions from engines associated with marine vessels, compressors, generators, and cranes. Impacts associated with the proposed Project construction would be expected to be short-term, negligible, and adverse. Other construction activities such as welding would generate minor emissions, but these would be minor relative to the combustion emissions. Fugitive particulate matter emissions typically associated with construction projects would not occur for the offshore portions of the proposed Project construction.

Construction-related offshore equipment that would generate air emissions includes the following vessels during each construction task:

- Pipeline installation: pipelay barge, two anchor haul tugs, pipe haul barge with tow tug, survey vessel, and supply vessel.

- Flooding and testing: Four-point moored dive vessel, and support tug.
- Trenching: trench barge, two anchor haul tugs, survey vessel, and supply vessel.
- Diving: four-point moored dive vessel, support tug, and spool transport vessel.
- Pre-commissioning: four-point moored dive vessel, and support tug.
- TYMS installation: derrick barge, three material tugs, one anchor haul tug, and supply vessel.

4.9.1.1 Construction Emissions

Table 4.9-1 presents potential emissions from construction of the offshore Project components. Construction emission estimates were based on the duration of operation for each vessel, and the total rated horsepower for each vessel's engines. Total days and hours of operation for each vessel were based on Delfin LNG's Project schedule. Vessel horsepower ratings were based on actual example vessels representative of those likely to be used for the Project. Emission factors were obtained from BOEM's Year 2011 Gulfwide Emission Inventory Study (BOEM 2011d).

Table 4.9-1. Proposed WC 167 Bypass, Subsea Lateral Pipeline, and TYMS Construction Emissions

Activity	Emissions (tons per year)					
	PM_{10} and $PM_{2.5}$	Sulfur Dioxide (SO_2)	Nitrogen Oxide (NO_x)	Volatile Organic Compounds (VOCs)	Carbon Monoxide (CO)	Carbon Dioxide Equivalents (CO_2e)
Pipeline Installation	3.65	16.73	125.4	3.78	27.36	8,970
Flooding and Testing	0.51	2.32	17.4	0.52	3.79	1,244
Trenching	3.12	14.34	107.5	3.23	23.46	7,689
Diving	7.04	32.31	242.1	7.26	52.82	17,316
Precommissioning	1.72	7.85	58.8	1.76	12.84	4,209
TYMS for FLNGV #1	6.1	28	210	6.3	45.8	15,024
Year 1 Subtotal	***20.4***	***93.71***	***702.4***	***21.1***	***153.2***	***54,453***
TYMS for FLNGV #2	6.1	28	210	6.3	45.8	15,024
TYMS for FLNGV #3	6.1	28	210	6.3	45.8	15,024
TYMS for FLNGV #4	6.1	28	210	6.3	45.8	15,024
Years 2-4 Subtotal	***18.3***	***84***	***630***	***18.9***	***137.4***	***45,072***
Grand Total	**38.7**	**177.7**	**1,332.4**	**40.0**	**290.6**	**99,525**

Key:
FLNGV = floating liquefied natural gas vessel
PM_{10} = particular matter smaller than 10 microns
$PM_{2.5}$ = particulate matter smaller than 2.5 microns
TYMS = tower yoke mooring system

4.9.2 Impacts of Operation

Impacts associated with the proposed Project operation would be expected to be long-term, minor, and adverse. Emissions generated from proposed Project operations were evaluated based on data provided by Delfin LNG in their Deepwater Port Application, as amended on November 19, 2015. Air quality impacts for the offshore portion of the Project were evaluated based on a dispersion modeling analysis provided by Delfin LNG on April 29, 2016. A detailed summary of the air quality impact analysis for criteria pollutants is presented in Section 4.9.2.2.

This modeling analysis demonstrates that operating impacts for the offshore portion of the Project would be in compliance with all Federal and State guidelines for acceptable ambient pollutant concentrations. However, it should be understood that the analysis was performed using a draft modeling protocol, which was submitted to the USEPA but has not yet been approved. The air permit application that Delfin LNG submits to the USEPA must also include a dispersion modeling analysis, which may differ from the analysis relied upon in this final EIS if the USEPA requires changes to Delfin LNG's modeling protocol.

4.9.2.1 Operation Emissions

Operational emissions from the offshore portion of the Project would be produced by stationary sources onboard each of the four FLNGVs, and from mobile sources, which would include visiting LNG carriers, support vessels, and helicopter flights. Activities producing emissions during operation have been grouped into four distinct scenarios:

- initial startup and commissioning,
- routine operation,
- liquefaction train restart flaring emissions, and
- heavy weather FLNGV disconnect/reconnect.

Stationary Source Descriptions

Each FLNGV would include the following stationary emission sources:

- Three General Electric (GE) LM6000PF+ gas turbines connected to refrigerant compressors.
- Three GE LM2500+ power generation gas turbines, dual-fuel capable. Two units would be in operation with the third unit as a running standby unit. All units would be fitted with waste heat recovery units to supply heat to a hot oil system for onboard users.
- One acid gas recovery unit exhausting to a thermal oxidizer. The thermal oxidizer exhausts to atmosphere.
- One common flare stack with three flare burners for warm (wet), cold (dry), and low pressure (marine) gases.
- One condensate storage tank.
- Three Hundai-Himsen 14H3240V dual-fuel essential generator engines rated at 6,650 kilowatts (kW) each, which would operate only for maintenance and testing purposes during routine FLNGV operation. During heavy weather operations, all three essential generators would operate to provide propulsion power for the FLNGV.
- Two diesel-engine emergency generators, 1.2 MW each, routinely tested once per week for two hours.
- Two diesel-engine firewater pump engines, 1.2 MW each, routinely tested once per week for two hours.
- Fugitive emissions due to leaks primarily from valves in gas service and pump seals.

Stationary Source Emissions

Table 4.9-2 shows potential emissions for initial startup of the liquefaction trains on each FLNGV. The initial startups of the four FLNGVs would be staggered such that only one FLNGV would begin operation each calendar year, from 2019 through 2022. Delfin LNG estimated emissions based on the following sequence of steps for initial startup and commissioning of the three liquefaction trains aboard each FLNGV:

- purging of nitrogen from the feed gas system, production of sweet/dry gas from the purification and dehydration system, and initial regeneration of the molecular sieves;

- dry-out of the cryogenic feed/propane/ethylene circuits and regeneration of driers using hot, dry gas;
- defrosting of the propane, ethylene, and methane units, charging the propane and ethylene circuits with propane and ethylene, with purging to the flare until the desired purity in the respective circuits is obtained;
- plant cooldown via operation of the LNG train at very low rates until required pressure and temperature conditions are established, with the gas stream from this process sent to the flare; and
- LNG tanks cool down via routing LNG from the cold box to the storage tank. As LNG cools down the tank, vaporization occurs with gas routed to the flare.

Most of the emissions during initial startup and commissioning would be due to flaring and venting of gases produced during each step of the process. Delfin has estimated that the above sequence of steps would take approximately 406 hours (about 17 days) for each liquefaction train.

Table 4.9-2. Emissions from Initial Startup and Commissioning per FLNGV

FLNGV and Startup Year	Emissions (tons per year)								
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	CO_2	CH4	N_2O	CO_2e
FLNGV #1 (2019)	24	132	0.3	0.3	22.5	41,931	51	0.09	41,958
FLNGV #2 (2020)	24	132	0.3	0.3	22.5	41,931	51	0.09	41,958
FLNGV #3 (2021)	24	132	0.3	0.3	22.5	41,931	51	0.09	41,958
FLNGV #4 (2022)	24	132	0.3	0.3	22.5	41,931	51	0.09	41,958
Total	**96**	**528**	**1.2**	**1.2**	**90**	**167,724**	**204**	**0.36**	**167,832**

Table 4.9-3 shows potential annual emissions for routine operation of one FLNGV, while Table 4.9-4 shows total potential emissions from routine operation of all four FLNGVs. Continuous sources were assumed to operate for 8,760 hours per year, while intermittent sources were limited to 500 hours of operation per year.

Table 4.9-3. Potential Emissions for Annual Operations for One FLNGV

Emission Sources	Emissions (tons per year)						
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	HAP	CO_2e
Continuous Sources							
Gas Turbines – Refrigeration Compressors	565	1,371	0	41	13	6	685,602
Gas Turbines – Power Generation	315	193	0	23	7	3	386,895
AGRU Thermal Oxidizer	17	15	46	1	1	0.3	87,560
Fugitive a/	0	0	0	0	2	0	50
Flares b/	20	108	0	2	1	0	39,517
Subtotal	*917*	*1,687*	*46*	*67*	*24*	*9*	*1,199,624*

Table 4.9-3. Potential Emissions for Annual Operations for One FLNGV (continued)

Emission Sources	Emissions (tons per year)						
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	HAP	CO_2e
Intermittent Sources c/							
Diesel Engines – 3 Marine Essential Generators	87	39	0.5	4.6	4.1	0.2	7,661
Diesel Engines – 2 Emergency Generators	1	1	0	0.1	0.1	0	189
Diesel Engines – 2 Firewater Pump	2	2	0	0.1	0.2	0	314
Subtotal	*90*	*42*	*0.5*	*4.8*	*4.4*	*0.2*	*8,164*
Grand Total	**1,007**	**1,729**	**46**	**72**	**28.4**	**10**	**1,207,788**

Notes:
a/ Fugitive emissions are assumed controlled by 97% per USEPA guidance.
b/ Sum of warm, cold and marine flare. Includes emissions from upsets and maintenance during Year 1.
c/ Intermittent sources operate only for routine maintenance and testing runs.

Table 4.9-4. Potential Emissions for Annual Operations for Four FLNGVs

Emission Sources	Emissions (tons per year)						
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	HAP	CO_2e
Continuous Sources							
Gas Turbines – Refrigeration Compressors	2,260	5,484	0	164	52	24	2,742,408
Gas Turbines – Power Generation	1,260	772	0	92	28	12	1,547,580
AGRU Thermal Oxidizer	68	60	184	4	4	1.2	350,240
Fugitive a/	0	0	0	0	8	0	200
Flares b/	80	432	0	8	4	8	158,068
Subtotal	*3,668*	*6,748*	*184*	*268*	*96*	*45*	*4,798,496*
Intermittent Sources c/							
Diesel Engines – 3 Marine Essential Generators	348	156	2	18	16	1	30,644
Diesel Engines – 2 Emergency Generators	4	4	0	0.4	0.4	0	756
Diesel Engines – 2 Firewater Pump	8	8	0	0.4	0.8	0	1,256
Subtotal	*360*	*168*	*2*	*19*	*17*	*1*	*32,656*
Grand Total	**4,028**	**6,916**	**186**	**287**	**113**	**46**	**4,831,152**

Notes:
a/ Fugitive emissions are assumed controlled by 97% per USEPA guidance.
b/ Sum of warm, cold and marine flare. Includes emissions from upsets and maintenance during Year 1.
c/ Intermittent sources operate only for routine maintenance and testing runs.

Table 4.9-5 shows potential annual emissions due to anticipated restart events for the liquefaction trains on each FLNGV during its first year of operation. Table 4.9-6 shows anticipated liquefaction train restart emissions during operating years 2 through 5 for each FLNGV. Delfin has estimated restart emissions based on the following sequence of events:

- Event 1A – Liquefaction Train 1 Unplanned Outage/Warm Start (per FLNGV): This event covers only the period of time between startup of Train 1 and startup of Train 2, when a single train (Train 1) outage would result in loss of capability to recover boil-off gas (BOG) from LNG storage. The duration of the loss of BOG recovery (3 days per event) is conservative to cover more frequent but much shorter cold restart events as well). After Train 2 starts, BOG recovery is considered to be unaffected thereafter by single liquefaction train outages.
- Event 1B – Liquefaction Train Unplanned Warm Start: Single train outages, which are long enough to require extended cooldown of cryogenic equipment during startup. Covers the entire period except the time between startup of Train 1 and startup of Train 2.
- Event 2A – Unplanned Liquefaction Train Cold Box Repair – Warm Restart: Only single train cold box repairs are considered.
- Event 3A – Liquefaction Train Unplanned Outages (short) – Cold Restart: Single train outages, which are short enough to keep the cryogenic equipment cold. Limited flaring is required.
- Event 3B – Liquefaction Train Unplanned Outages (long) – Cold Restart: Single train outages with durations between Event 2A and 3A. Some cooldown is required.
- Event 4A – Planned Liquefaction Turnarounds – Warm Restart: One per train for compressor suction strainer changeout in the first year. Frequency thereafter is each 5 years.
- Event 4B – Extended Site Power Outage: Site Power outage results in complete loss of production and BOG recovery (two days per event), followed by warm restart of all three liquefaction trains.
- Event 4C – Brief Site Power Outage/Cold Restart: Site Power outage results in loss of production and BOG recovery for 8 hours, with brief flaring required to cold restart all three trains.
- Event 5A – BOG Compressor Outage: Single compressor outage during loading mode operation. No outages during hold mode operation considered since sparing is N+2 for hold mode.
- Event 5B – Regen Compressor Outage: It is assumed that regen gas would be flared to avoid reduction of LNG production (regen compressors are not spared).

Table 4.9-5. Total Flaring Emissions from Liquefaction Train Restart Events per FLNGV – Year 1

Event Type	Emissions (tons per year)					
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	CO_2e
1A	1.80	9.79	0.02	0.19	0.08	3,114
1B	4.57	24.87	0.04	0.47	0.34	7,909
2A	0.00	0.00	0.00	0.00	0.00	-
3A	0.53	2.88	0.00	0.05	0.04	915
3B	1.06	5.76	0.01	0.11	0.08	1,831
4A	3.93	21.37	0.03	0.40	0.29	6,795
4B	3.07	16.69	0.03	0.32	0.21	5,306
4C	0.61	3.30	0.01	0.06	0.04	1,049
5A	2.09	11.40	0.02	0.22	0.00	3,624
5B	3.14	17.10	0.03	0.32	0.23	5,436
Total	**20.8**	**113.2**	**0.2**	**2.1**	**2.1**	**35,979**

Table 4.9-6. Total Flaring Emissions from Liquefaction Train Restart Events per FLNGV – Years 2-5

Event Type	Emissions (tons per year)					
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	CO_2e
1A	0.00	0.00	0.00	0.00	0.00	-
1B	2.86	15.55	0.02	0.29	0.21	4,923
2A	0.13	0.69	0.00	0.01	0.01	220
3A	0.53	2.88	0.00	0.05	0.04	915
3B	1.06	5.76	0.01	0.11	0.08	1,831
4A	0.79	4.27	0.01	0.08	0.06	1,359
4B	1.53	8.34	0.01	0.16	0.11	2,653
4C	0.61	3.30	0.01	0.06	0.04	1,049
5A	1.05	5.70	0.01	0.11	0.00	1,812
5B	1.57	8.55	0.01	0.16	0.12	2,718
Total	**10.1**	**55.0**	**0.1**	**1.0**	**11.2**	**17,500**

Each FLNGV would be capable of self-propulsion, and would be able to unmoor from its TYMS and depart from the Port in the event of hurricanes, tropical storms, or other heavy weather that was forecasted to exceed the safe metocean design limits for the Port components. In such an event, the FLNGV would travel up to 200 miles to reach a safer location in deep waters of the Gulf of Mexico. Table 4.9-7 shows potential emissions for a conservative assumption that each of the four FLNGVs would have one heavy weather disconnect and reconnect event per year.

Table 4.9-7. Potential Emissions for One Annual Heavy Weather Operation (Four FLNGVs)

Operating Scenario a/	Emissions (tons per year)					
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	CO_2e
Total Four FLNGVs	36	9	1	2	1	2,933
Note: a/ FLNGVs assumed to operate on LNG with a 1% pilot MDO fuel mixture						

The estimated emissions shown in Table 4.9-7 only include FLNGV activities that would occur within each TYMS safety zone during the disconnect and reconnect, since the FLNGVs would be heading into deeper waters rather than approaching shore. FLNGV emissions include the operation of all three Hyundai-Himsen essential generator engines onboard each FLNGV, and assume operation in dual-fuel mode with 99 percent boil-off gas and 1 percent MDO for pilot fuel. The disconnect/reconnect process was estimated to require 7 hours for disconnection, and up to 24 hours for reconnection upon return of the FLNGV to the TYMS.

The estimated emissions in Table 4.9-7 also include round-trip emissions from four tugboats traveling to the Port from Cameron, Louisiana, to assist in maneuvering the FLNGVs during disconnect and reconnect. It was assumed that three tugboats with a total engine rating of 6,000 hp each would be required to give forward positioning assistance, while the fourth tug, with a total engine rating of 4,000 hp, would be used for aft positioning assistance. Tugboat emission factors were taken from Table 6-1 of BOEM (2011d).

Mobile Source Emissions

Mobile source emissions occurring during operation of the Port would be generated by visiting LNG carriers, support vessels, and helicopter flights to and from each FLNGV. Table 4.9-8 shows annual potential emissions from mobile source activity at all four TYMS safety zones combined.

Table 4.9-8. Potential Emissions for Annual Operations of Mobile Sources

Emission Sources	Emissions (tons per year)						
	NO_x	CO	SO_2	PM_{10}/ $PM_{2.5}$	VOC	HAP	$CO_{2}e$
Support Vessels, LNGCs, and Helicopter in All Four Safety Zones							
LNG Carrier Transit to and from Safety Zone	119	12	35	5	5	N/A	5,354
LNG Carrier Emissions within Safety Zone a/	67	26	12	5	8	N/A	10,233
Tug Ops	592	133	7	22	8	N/A	38,417
Supply Vessel	4	1	0.1	0.2	0.1	N/A	324
Helicopter	0.1	0.1	0.0	0.0	0.10	0.28	11
Total	**782**	**172**	**54**	**32**	**21**	**0.28**	**54,339**

Note:
a/ LNGC emissions occur from maneuvering within the safety zone and hoteling while loading LNG. HAP factors for natural gas use not available.

LNG carriers would make an estimated 40 visits per year to each FLNGV. Delfin LNG has currently assumed that all LNG carriers visiting the Port would be diesel-propulsion vessels, with an assumed total engine rating of 45,500 hp for the purpose of this estimate. It was conservatively assumed that LNG carriers approaching the port would burn MDO exclusively, while departing LNG carriers were assumed to operate in dual-fuel mode with 99 percent boil-off gas and 1 percent MDO as pilot fuel. LNG carrier emission factors while firing MDO were based on the commercial marine vessel factors in Table 6-1 of BOEM (2011d). LNG carrier emissions while firing natural gas were based on a Wartsila 50DF example engine. Potential emissions were estimated for LNG carrier emissions occurring in each safety zone during maneuvering, mooring and unmooring from the FLNGV, and hoteling of the LNG carrier during the cargo transfer. In addition, LNG carrier emissions were estimated for the period of transit outside the safety zone that could reasonably be attributed directly to the operations of the Port. LNG carrier transit emissions were included for the inbound leg from 10 nautical miles away (which is where the mooring master would board the LNG carrier) to the edge of the safety zone, and for the outbound leg from the edge of the safety zone to the point at which the mooring master would depart and the LNG carrier would enter the Sabine Pass Safety Fairway, a distance of approximately 2.6 nautical miles.

For each LNG carrier arrival, four tugs would travel from Cameron, Louisiana, to assist with maneuvering and docking. Tugboat emission factors were taken from Table 6-1 of BOEM (2011d). It was assumed that three tugs would have a total engine rating of 6,000 hp, while the fourth would have a total engine rating of 4,000 hp. Two of the 6,000 hp tugs would remain on standby at the Port during the cargo transfer and assist the LNG carrier with unmooring, while the other two tugboats would return to shore.

One supply vessel, assumed to have a total engine rating of 1,800 hp, would make a weekly round-trip from Cameron, Louisiana to service all four FLNGVs. Supply vessel emission factors were based on the commercial marine vessel factors in Table 6-1 of BOEM (2011d).

One helicopter would make a weekly round-trip from Cameron, Louisiana to service the Port, with one landing and takeoff at each FLNGV. Helicopter emission factors were based on the twin-engine medium lift factors in Table 6-12 of BOEM (2011d).

4.9.2.2 Operational Air Quality Impacts

An air quality dispersion modeling analysis was performed to achieve the following:

- demonstrate compliance with Prevention of Significant Deterioration (PSD) Class II increments,

- demonstrate compliance with National Ambient Air Quality Standards (NAAQS), and
- satisfy the NEPA requirement to assess cumulative impacts.

It was not necessary to perform an analysis of Class I area impacts because the closest Class I area, the Breton National Wildlife Refuge, would be located approximately 440 km from the Project.

Model Selection

Delfin LNG conducted modeling in accordance with a draft PSD modeling protocol submitted to USEPA Region 6 on May 8, 2015. In order to model the specific conditions that occur above water, Delfin used a modified version of AERMOD Version 14134, in combination with the Coupled Ocean Atmosphere Response Experiment (COARE) enhancements. This version of AERMOD is known as AERMOD-COARE.

Typically, dispersion modeling begins with a screening-level analysis to determine whether the modeled impacts for a proposed project by itself would exceed one or more of the Significant Impact Levels (SILs) established by USEPA. If the modeled impact for a pollutant exceeds a SIL, then refined modeling must then be performed that would include the modeled impacts from other, nearby stationary sources of pollution. However, instead of first evaluating modeled impacts against the SILs, Delfin elected to proceed directly to refined modeling that included cumulative impacts from nearby existing sources for all pollutants. Delfin LNG used BOEM (2011d) to locate existing offshore stationary sources that would be located within 20 km of the proposed Port.

Operating Scenarios for Modeling

Modeled emission sources included the stationary sources onboard the FLNGVs, as well as emissions within the Project safety zones from visiting LNG carriers, and from tugboats during assistance with maneuvering and docking or undocking.

Delfin LNG modeled two operational scenarios:

- Hoteling Scenario – In this scenario, all FLGNV emission sources are operating, and each FLNGV has a diesel-driven LNG carrier moored alongside, with one of its engines operating to provide hoteling power during cargo transfer. For this scenario, tugboats are assumed to be moored with engines off at the service vessel mooring (SVM) locations outside of each ATBA/NAA.
- Transit Scenario – In this scenario, all FLNGV emission sources are operating, and each FLNGV is being approached by a diesel-driven LNG carrier as moves through the ATBA/NAA. Each LNG carrier is accompanied by four tugboats. Because AERMOD cannot accommodate a source that is moving, the LNG carriers and tugboats were represented as stationary sources located at a point midway between the boundary of the ATBA/NAA and the TYMS.

For modeling of 1-hour nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) impacts from the LNGCs and tugboats in the transit scenario, Delfin LNG used an "annualized" emission rate for these mobile sources, in which total annual transit emissions were divided evenly across 8,760 hours to account for the intermittent nature of these operations. For emissions that only occur during periods of malfunction, the USEPA does not require modeling to be performed. Therefore, the FLNGV flare emissions used for modeling only include pilot flames and maintenance activity; emissions from emergency releases were excluded from modeling.

Selection of Background Monitoring Data

Since offshore monitoring sites for long-term ambient concentrations are not available, Delfin LNG selected the nearest available onshore monitoring sites. This approach is conservative since offshore ambient concentrations are likely to be lower than onshore concentrations. Background concentrations for the 3-year period of 2012 through 2014 were used, from the following monitoring sites: Westlake, LA (220190008) for NO_2 and SO_2; Jefferson County, TX (482451035) for carbon monoxide (CO); Lake

Charles, LA (220190010) for particulate matter with an aerodynamic diameter less than or equal to 2.5 microns ($PM_{2.5}$); and Lafayette, LA (220550007) for particulate matter with an aerodynamic diameter less than or equal to 10 microns (PM_{10}).

Receptor Locations

Delfin LNG selected the edge of the ATBA/NAA around each TYMS to represent the ambient air boundary for modeling. The ATBA/NAA boundary forms a circle around each TYMS with a radius of 1,416 m, which is an additional 500 m past the safety zone boundary. Modeling receptors were placed along each ATBA/NAA boundary at 100-m intervals, and then in a square grid pattern at intervals of 100 m out to 2,500 m from the ATBA/NAA boundary; and at intervals of 250 m out to 7,500 m from the ATBA/NAA boundary.

Using the outside edge of the ATBA/NAA as the ambient air boundary is not as conservative an approach as that used for modeling analyses of other deepwater ports, which typically choose the safety zone boundary to represent the "fenceline" for an offshore facility. In the event that the USEPA recommends using a different ambient air boundary when Delfin LNG performs modeling as part of its PSD/New Source Review (NSR) air permit application to the USEPA, then the modeling analysis used for this final EIS will need to be revised as well.

Selection of Meteorological Data

Delfin LNG selected overwater hourly meteorological data from NOAA's National Data Buoy Center for the 5-year period of 2009 through 2013. The nearest available buoy with sufficiently complete data was Buoy 42035, located in the Gulf of Mexico approximately 48.6 nautical miles west of the proposed Port. Two other buoys, FGBL1 and 42047, were used as sources of substitute data for periods when Buoy 42035 had a data gap longer than 10 hours. These buoys were located in deeper waters to the south of the proposed Port.

NO_2 Modeling Approach

Delfin LNG modeled NO_2 impacts using the "Tier 2" approach recommended by USEPA in Appendix W to 40 CFR 51, which assumes that only a portion of the NO_x emissions from each source is converted to NO_2 in the atmosphere. USEPA's original Tier 2 approach uses an "Ambient Ratio Method" (ARM), which allows modelers to assume that only 75 percent of each source's NOx emissions are converted to NO_2, and Delfin LNG used this assumption modeling annual NO_2 impacts. However, for modeling 1-hour NO_2, Delfin LNG selected a revised approach known as "Ambient Ratio Method 2" (ARM2), which USEPA proposed in July 2015 based on a new analysis of ambient monitoring data, showing that the ratio of NO_2 to NO_x can vary on a short-term basis. Delfin LNG's 1-hour NO_2 impacts assumed a variable NO_x-to-NO_2 conversion rate that ranged between 50 and 90 percent.

Model Input Parameters

Table 4.9-9 presents the model input parameters used for the Project emission sources in both the hoteling and transit scenarios. Table 4.9-10 presents the model input parameters used for nearby cumulative sources. Delfin LNG used BOEM (2011d) to locate existing offshore stationary sources that would be located within 20 km of the proposed Port. Out of eight nearby platform facilities identified, only two reported emissions in the BOEM database. Since the database did not include exhaust parameters for these sources, Delfin LNG substituted worst-case default stack parameters. The emission rates presented in Table 4.9-10 were calculated by converting the 2011 tons per year totals in the BOEM database to hourly values assuming continuous operation for 8,760 hours per year.

Table 4.9-9. Model Input Parameters for Project Point Sources

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	Stack Diam. (ft)	NO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	$PM_{2.5}$ (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)	SO_x (lb/hr)
V1_GTA	Refrig Comp Turbine 1	448030.4	3223692	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V1_GTB	Refrig Comp Turbine 1	448030.4	3223594	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V1_GTC	Refrig Comp Turbine 1	447991.6	3223668	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V1_GTGA	Power Gen Turbine 1	447992.5	3223742	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V1_GTGB	Power Gen Turbine 2	448035	3223738	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V1_GTGC	Power Gen Turbine 3 (Standby)	448026.6	3223737	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V1_AGV	Thermal Oxidizer	447986.6	3223551	0	144.7	1500	16.4	6.5	3.97	3.97	3.32	0.3	0.3	10.39	10.39
V1_WFLR	Warm (Wet) Flare - MAX	448023.6	3223479	0	233.8	1832	65.6	3.29	0.826	0.826	491.78	0	0	0.27	0.27
V1_CFLR	Cold (dry) flare - MAX	448023.6	3223479	0	233.8	1832	65.6	3.27	3.022	3.022	576	0	0	0.31	0.31
V1_MFLR	Marine Flare - MAX	448023.6	3223479	0	233.8	1832	65.6	2.69	0.648	0.648	124.32	0	0	0.07	0.07
V1_EGA	Diesel Emerg Gen 1	448011.5	3223747	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V1_EGB	Diesel Emerg Gen 2	448011.5	3223747	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V1_FWPA	Firewater Pump Engine 1	448011.5	3223747	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V1_FWPB	Firewater Pump Engine 2	448011.5	3223747	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V1_EGENA	FLNGV Essential Gen Engine 1	448028.2	3223766	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V1_EGENB	FLNGV Essential Gen Engine 2	448024.4	3223766	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V1_EGENC	FLNGV Essential Gen Engine 3	448020.5	3223766	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V2_GTA	Refrig Comp Turbine 1	446904.1	3219872	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V2_GTB	Refrig Comp Turbine 1	446904.1	3219774	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V2_GTC	Refrig Comp Turbine 1	446865.4	3219848	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V2_GTGA	Power Gen Turbine 1	446866.2	3219922	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V2_GTGB	Power Gen Turbine 2	446908.8	3219917	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V2_GTGC	Power Gen Turbine 3 (Standby)	446900.3	3219916	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V2_AGV	Thermal Oxidizer	446860.3	3219731	0	144.7	1500	16.4	6.5	3.97	3.97	3.32	0.3	0.3	10.39	10.39
V2_WFLR	Warm (Wet) Flare - MAX	446897.4	3219658	0	233.8	1832	65.6	3.29	0.826	0.826	491.78	0	0	0.27	0.27
V2_CFLR	Cold (dry) flare - MAX	446897.4	3219658	0	233.8	1832	65.6	3.27	3.022	3.022	576	0	0	0.31	0.31
V2_MFLR	Marine Flare - MAX	446897.4	3219658	0	233.8	1832	65.6	2.69	0.648	0.648	124.32	0	0	0.07	0.07
V2_EGA	Diesel Emerg Gen 1	446885.2	3219927	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V2_EGB	Diesel Emerg Gen 2	446885.2	3219927	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V2_FWPA	Firewater Pump Engine 1	446885.2	3219927	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V2_FWPB	Firewater Pump Engine 2	446885.2	3219927	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V2_EGENA	FLNGV Essential Gen Engine 1	446902	3219946	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V2_EGENB	FLNGV Essential Gen Engine 2	446898.1	3219946	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V2_EGENC	FLNGV Essential Gen Engine 3	446894.3	3219946	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89

Table 4.9-9. Model Input Parameters for Project Point Sources (continued)

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	Stack Diam. (ft)	NO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	$PM_{2.5}$ (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)	SO_x (lb/hr)
V3_GTA	Refrig Comp Turbine 1	451098.2	3220712	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V3_GTB	Refrig Comp Turbine 1	451098.2	3220614	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V3_GTC	Refrig Comp Turbine 1	451059.4	3220688	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V3_GTGA	Power Gen Turbine 1	451060.3	3220762	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V3_GTGB	Power Gen Turbine 2	451102.8	3220757	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V3_GTGC	Power Gen Turbine 3 (Standby)	451094.4	3220756	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V3_AGV	Thermal Oxidizer	451054.4	3220571	0	144.7	1500	16.4	6.5	3.97	3.97	3.32	0.3	0.3	10.39	10.39
V3_WFLR	Warm (Wet) Flare - MAX	451091.4	3220498	0	233.8	1832	65.6	3.29	0.826	0.826	491.78	0	0	0.27	0.27
V3_CFLR	Cold (dry) flare - MAX	451091.4	3220498	0	233.8	1832	65.6	3.27	3.022	3.022	576	0	0	0.31	0.31
V3_MFLR	Marine Flare - MAX	451091.4	3220498	0	233.8	1832	65.6	2.69	0.648	0.648	124.32	0	0	0.07	0.07
V3_EGA	Diesel Emerg Gen 1	451079.3	3220767	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V3_EGB	Diesel Emerg Gen 2	451079.3	3220767	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V3_FWPA	Firewater Pump Engine 1	451079.3	3220767	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V3_FWPB	Firewater Pump Engine 2	451079.3	3220767	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V3_EGENA	FLNGV Essential Gen Engine 1	451096.1	3220786	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V3_EGENB	FLNGV Essential Gen Engine 2	451092.2	3220786	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V3_EGENC	FLNGV Essential Gen Engine 3	451088.3	3220786	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V4_GTA	Refrig Comp Turbine 1	449961.9	3217139	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V4_GTB	Refrig Comp Turbine 1	449961.9	3217041	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V4_GTC	Refrig Comp Turbine 1	449923.1	3217115	0	191.1	923.8	253.4	7.21	43	43	104.35	3.1	3.1	0	0
V4_GTGA	Power Gen Turbine 1	449924	3217189	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V4_GTGB	Power Gen Turbine 2	449966.5	3217184	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V4_GTGC	Power Gen Turbine 3 (Standby)	449958.1	3217184	0	191.1	450	109.7	8.53	24	24	14.7	1.75	1.75	0	0
V4_AGV	Thermal Oxidizer	449918.1	3216998	0	144.7	1500	16.4	6.5	3.97	3.97	3.32	0.3	0.3	10.39	10.39
V4_WFLR	Warm (Wet) Flare - MAX	449955.1	3216925	0	233.8	1832	65.6	3.29	0.826	0.826	491.78	0	0	0.27	0.27
V4_CFLR	Cold (dry) flare - MAX	449955.1	3216925	0	233.8	1832	65.6	3.27	3.022	3.022	576	0	0	0.31	0.31
V4_MFLR	Marine Flare - MAX	449955.1	3216925	0	233.8	1832	65.6	2.69	0.648	0.648	124.32	0	0	0.07	0.07
V4_EGA	Diesel Emerg Gen 1	449943	3217194	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V4_EGB	Diesel Emerg Gen 2	449943	3217194	0	69.7	800	131.2	0.5	0.109	0.109	9.22	0.396	0.396	0.13	0.13
V4_FWPA	Firewater Pump Engine 1	449943	3217194	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V4_FWPB	Firewater Pump Engine 2	449943	3217194	0	69.7	800	131.2	0.5	0.181	0.181	15.37	0.66	0.66	0.22	0.22
V4_EGENA	FLNGV Essential Gen Engine 1	449959.8	3217213	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V4_EGENB	FLNGV Essential Gen Engine 2	449955.9	3217213	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89
V4_EGENC	FLNGV Essential Gen Engine 3	449952	3217213	0	194.3	653	194.1	2.6	6.615	6.615	51.9	2.24	2.24	0.6	0.89

Table 4.9-9. Model Input Parameters for Project Point Sources (continued)

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	Stack Diam. (ft)	NO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	$PM_{2.5}$ (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)	SO_x (lb/hr)
Hoteling Carriers															
VI_LNGC	LNG Carrier Hoteling	447936.8	3223611	0	147.6	755	57.4	4.92	11.83	1.62	8.28	1.16	1.17	0.47	0.47
V2_LNGC	LNG Carrier Hoteling	446814.8	3219790	0	147.6	755	57.4	4.92	11.83	1.62	8.28	1.16	1.17	0.47	0.47
V3_LNGC	LNG Carrier Hoteling	451008.8	3220623	0	147.6	755	57.4	4.92	11.83	1.62	8.28	1.16	1.17	0.47	0.47
V4_LNGC	LNG Carrier Hoteling	449870.8	3217051	0	147.6	755	57.4	4.92	11.83	1.62	8.28	1.16	1.17	0.47	0.47
Transiting Carriers and Tugs															
V1_TCAR	LNG Carrier Transiting	447936.8	3223211	0	147.6	755	90.2	4.92	2	2	13.24	0.636	0.692	0.6	44.13
V1_TTUG1	Tug Transiting	447830.6	3223346	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V1_TTUG2	Tug Transiting	448034	3223346	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V1_TTUG3	Tug Transiting	447830.6	3223156	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V1_TTUG4	Tug Transiting	448037.8	3223156	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V2_TCAR	LNG Carrier Transiting	446814.8	3219390	0	147.6	755	90.2	4.92	2	2	13.24	0.636	0.692	0.6	44.13
V2_TTUG1	Tug Transiting	446708.6	3219525	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V2_TTUG2	Tug Transiting	446912	3219525	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V2_TTUG3	Tug Transiting	446708.6	3219335	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V2_TTUG4	Tug Transiting	446915.8	3219335	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V3_TCAR	LNG Carrier Transiting	451008.8	3220223	0	147.6	755	90.2	4.92	2	2	13.24	0.636	0.692	0.6	44.13
V3_TTUG1	Tug Transiting	450902.6	3220358	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V3_TTUG2	Tug Transiting	451106	3220358	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V3_TTUG3	Tug Transiting	450902.6	3220168	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V3_TTUG4	Tug Transiting	451109.8	3220168	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V4_TCAR	LNG Carrier Transiting	449870.8	3216651	0	147.6	755	90.2	4.92	2	2	13.24	0.636	0.692	0.6	44.13
V4_TTUG1	Tug Transiting	449764.6	3216786	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V4_TTUG2	Tug Transiting	449968	3216786	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V4_TTUG3	Tug Transiting	449764.6	3216596	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72
V4_TTUG4	Tug Transiting	449971.8	3216596	0	35	850	40.3	1.5	2.55	2.55	31.26	0.83	0.859	0.03	1.72

Key:

ID = identification; m = meter = ft = feet; F = Fahrenheit; ft/s = feet per second; lb/hr = pound per hour; NO_2 = nitrogen dioxide; NO_x = nitrous oxides; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; SO_2 = sulfur dioxide; SO_x = sulfur oxide

Table 4.9-10. Model Input Parameters for Offshore Platform Sources

Source ID	Company	Source Type	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	NO_2 (lb/hr)	CO (lb/hr)	$PM_{2.5}$ (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)
2053	Energy Partners of Delaware, Ltd.	Caisson	441998.18	3226390.26	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A
2131	Breton Energy, LLC	Other	468464.26	3229222.41	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A
22321	Apache Corporation	1 boiler (446 scf/hr) 3 diesel engines (238/95/95 hp) 1 gas engine (1600 hp)	440236.82	3240526.53	0	35	70	0.0003	14.8	19.8	0.457	0.457	0.156
23629	Apache Corporation	1 boiler (465 scf/hr)	453903.75	3226412.50	0	35	70	0.0003	2.23E-04	1.87E-04	9.91E-06	9.91E-06	1.34E-06
29053	Eni Petroleum Co. Inc.	Other	469453.44	3228154.20	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A
637	Hunt Oil Company	Other	441480.12	3239023.83	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A
849	Apache Corporation	Caisson	437166.65	3227513.24	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A
917	Hunt Oil Company	Caisson	441173.54	3235950.35	0	35	70	0.0003	N/A	N/A	N/A	N/A	N/A

Key:
ID = identification; m = meter = ft = feet; F = Fahrenheit; ft/s = feet per second; lb/hr = pound per hour; NO_2 = nitrogen dioxide; NO_x = nitrous oxides; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; SO_2 = sulfur dioxide; SO_x = sulfur oxide

Summary of Results

Tables 4.9-11 and 4.9-12 compare the modeled impacts of the Project sources plus cumulative sources to the allowable PSD Class II increments, for the hoteling and transit scenarios, respectively. For evaluating compliance with annual allowable increments, Delfin LNG used the highest modeled annual average in the 5-year modeling period. For evaluating compliance with short-term increments, Delfin LNG used the high-second-high values in the 5-year modeling period. As shown, the modeled impacts show compliance with all allowable increments.

Table 4.9-11. Hoteling Scenario Results vs. PSD Class II Increments

Pollutant	Averaging Period	Rank	Modeled Impact ($\mu g/m^3$)	PSD Class II Increment ($\mu g/m^3$)	Percent of Standard
NO_2	Annual	1st	2.08	25	8%
SO_2	24-hour	2nd	5.29	91	6%
PM_{10}	24-hour	2nd	4.34	30	14%
	Annual	1st	0.70	17	4%
$PM_{2.5}$	24-hour	2nd	4.34	9	48%
	Annual	1st	0.70	4	17%

Table 4.9-12. Transit Scenario Results vs. PSD Class II Increments

Pollutant	Averaging Period	Rank	Modeled Impact ($\mu g/m^3$)	PSD Class II Increment ($\mu g/m^3$)	Percent of Standard
NO_2	Annual	1st	2.82	25	11%
SO_2	24-hour	2nd	23.38	91	26%
PM_{10}	24-hour	2nd	5.99	30	20%
	Annual	1st	1.02	17	6%
$PM_{2.5}$	24-hour	2nd	5.92	9	66%
	Annual	1st	1.01	4	25%

Tables 4.9-13 and 4.9-14 compare the total modeled impacts for Project sources and cumulative sources plus the existing background concentration against the NAAQS, for the hoteling and transit scenarios, respectively. As shown, the predicted total impacts show compliance with all NAAQS standards.

Table 4.9-13. Hoteling Scenario Results vs. NAAQS

Pollutant	Averaging Period	Rank	Modeled Impact ($\mu g/m^3$)	Background Concentration ($\mu g/m^3$)	Total Impact ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of Standard
NO_2	1-hour	1st	40.31	54.81	95.1	188	51%
	Annual	1st	2.08	9.82	11.9	100	12%
CO	1-hour	2nd	1198.10	846	2044.1	40000	5%
	8-hour	2nd	460.05	686	1146.0	10000	11%
SO_2	1-hour	1st	17.36	94.3	111.7	196	57%
PM_{10}	24-hour	6th	4.10	85.3	89.4	150	60%
$PM_{2.5}$	24-hour	1st	3.10	17.8	20.9	35	60%
	Annual	1st	0.64	7.9	8.5	12	71%

Table 4.9-14. Transit Scenario Results vs. NAAQS

Pollutant	Averaging Period	Rank	Modeled Impact (µg/m³)	Background Concentration (µg/m³)	Total Impact (µg/m³)	NAAQS (µg/m³)	Percent of Standard
NO_2	1-hour	1st	45.33	54.81	100.1	188	53%
	Annual	1st	2.82	9.82	12.6	100	13%
CO	1-hour	2nd	1358.77	846	2204.8	40000	6%
	8-hour	2nd	551.31	686	1237.3	10000	12%
SO_2	1-hour	1st	17.10	94.3	111.4	196	57%
PM_{10}	24-hour	6th	5.18	85.3	90.5	150	60%
$PM_{2.5}$	24-hour	1st	3.90	17.8	21.7	35	62%
	Annual	1st	0.93	7.9	8.8	12	74%

4.9.3 Impacts of Decommissioning

Proposed Project decommissioning would result in comparable emissions to those described for the construction process. Impacts associated with proposed Project decommissioning would be expected to be short-term, negligible, and adverse.

During decommissioning, the proposed WC 167 bypass, lateral pipelines, and TYMS would be abandoned in-place to be consistent with current Federal policies to minimize adverse impacts. Minor air emissions are anticipated for these activities.

4.9.4 General Conformity

Under Section 176(c)(1) of the CAA, a General Conformity applicability evaluation is required for Federal actions that would result in emissions of criteria pollutants in an area designated as a nonattainment or maintenance area with respect to the NAAQS. If such emissions exceed certain thresholds, a more thorough General Conformity determination is required in order to demonstrate that the activity would comply with all applicable SIPs.

No emissions from construction or operation of the Project would occur in any designated nonattainment or maintenance area. Therefore, no further evaluation of potential Project emissions with respect to General Conformity is required.

4.9.5 Greenhouse Gases and Climate Change

As described in Section 3.9.5.3, GHGs are compounds in the atmosphere that inhibit the radiation of heat back out through the atmosphere resulting in a greenhouse effect that may affect the global climate. GHGs include pollutants resulting from the combustion of fossil fuels as well as fugitive emissions. Marine vessels and stationary sources used during construction, operation, and decommissioning would produce emissions of GHGs, primarily carbon dioxide (CO_2) and to a lesser extent methane (CH_4) and nitrous oxide (N_2O). Fugitive CH4 emissions may also occur from fugitive losses of LNG from valves, flanges, and other components of the natural gas handling system. These GHGs have different levels of global warming potential (GWP) that are normalized to CO_2e (carbon dioxide equivalent). For example, one ton of CH4 has a GWP equal to 25 tons of CO_2 and therefore one ton of CH_4 equates to 25 tons CO_2e. Similarly, one ton of N_2O has a GWP of 298. Although CH_4 and N_2O have greater GWPs than CO_2, proposed Project emissions of these GHGs are dramatically lower than CO_2 and as a result have only a minor impact on total GHG emissions from the proposed Project.

The CEQ has issued final guidance regarding the evaluation of GHG emissions and climate change impacts as part of NEPA analyses (CEQ 2016). The CEQ acknowledges in its guidance that "the totality of climate change impacts is not attributable to any single action," and therefore recommends that NEPA analyses use the "projected GHG emissions (to include, where applicable, carbon sequestration implications associated with the proposed agency action) as a proxy for assessing potential climate change effects" (CEQ 2016). CEQ also recommends that the following aspects be considered as part of the GHG and climate change evaluation, to the extent that is commensurate with the quantity of projected GHG emissions:

- differential GHG emissions from alternatives to the proposed action;
- the potential for mitigation of GHG impacts, including the use of, for example, carbon capture and sequestration (CCS), lower GHG emitting technology, and energy efficiency; and
- the potential for effects of climate change to worsen other environmental impacts of an action, or possibly to shorten the projected life of a project.

The scope of this EIS focuses on the direct and indirect impacts of the proposed LNG facility that is subject to MARAD's Federal action, the licensing of the construction and operation of the LNG facility, and the Federal actions of cooperating agencies, including but not limited to the FERC (certificating onshore components of the LNG facility) and USEPA (permitting under CWA and CAA). In response to the review of the draft EIS, a comment received from the USEPA (by letter dated August 29, 2016) recommended that the final EIS include an estimation of GHG emissions associated with the production, transportation, and combustion of the natural gas proposed to be exported. While this EIS does include an estimation of GHG emissions related to construction, operation and decommissioning activities, it does not include an analysis of upstream effects from potential induced production or downstream effects from the export of natural gas.

For this Project, Delfin LNG proposes to receive natural gas through its interconnection with other existing natural gas pipelines. The factors described under CEQ's regulations for a meaningful analysis—including when, where, and how natural gas development would occur as related to the proposed project—are unknown.[29] Additionally, the FERC has determined that, while upstream development and production of natural gas might be a "reasonably foreseeable" effect of a proposed action, the actual scope and extent of potential GHG emissions from upstream natural gas production is not reasonably foreseeable (see FERC 2015). CEQ's final guidance on evaluating GHG impacts does not require NEPA analyses to include such unforeseeable effects (CEQ 2016).

Regarding downstream GHG emissions from overseas transport, regasification and combustion of exported LNG, Delfin LNG has an application pending before DOE to export LNG to non-free trade agreement nations. The necessary factors for a meaningful analysis, including the demand for LNG exported from this Project, the destination(s) of the exports, the transport routes, and the ultimate end uses of the LNG, are unknown and, as such, the GHG emissions from same are not reasonably foreseeable.[30]

[29] The USEPA suggested that the final EIS consider DOE's *Addendum to Environmental review Documents Concerning Exports of Natural Gas from the United States*, wherein the agency provides additional information to the public regarding the potential environmental impacts of unconventional natural gas production activities. The Addendum provides GHG Emissions information from the upstream natural gas industry as a whole, but DOE recognized that lacking an understanding of where and when additional gas production will arise, the environmental impacts resulting from production activity induced by LNG exports to non-FTA countries are not "reasonably foreseeable" within the meaning of the CEQ NEPA regulations (40 CFR § 1508.7). See DOE (2014, p. 2).

[30] The USEPA suggested that the final EIS consider the analysis prepared by the DOE's National Energy Technology Laboratory (NETL) in 2014 into the estimated "life cycle" of GHG emissions for exporting LNG from the U.S. In the life cycle analysis, NETL identified two representative markets for U.S. exported LNG—Rotterdam, Netherlands, and Osaka, Japan—then compared the total greenhouse gases that would be emitted to generate one megawatt hour (MWh) of electricity in each market, using: (1) LNG imported from the United States; (2) LNG imported from closer regional sources; (3) natural gas exported via pipeline from Russia; and (4) regional coal. In each scenario, NETL considered carbon dioxide and methane emissions from all stages of fuel production, from

Therefore, potential GHG emissions from construction, operation, and decommissioning of the Project, as described in Section 2.0 of this final EIS, have been estimated in accordance with CEQ guidance. The GHG operation emissions presented below reflect the GHG BACT analysis Delfin LNG was required to include in its PSD air permit application to USEPA Region 6. This GHG BACT considered the feasibility of GHG mitigation measures including CCS, fuel selection, and energy efficiency.

4.9.5.1 Construction

For each type of vessel used during construction, GHG emission estimates were based on the duration of operation for each vessel, and the total rated horsepower for each vessel's engines. Total days and hours of operation for each vessel were based on Delfin LNG's project schedule. Vessel horsepower ratings were based on actual example vessels representative of those likely to be used for the Project. Emission factors for CO_2 and N_2O were obtained from BOEM (2011d).

GHG emissions during the construction period are provided in Table 4.9-1. Total GHG emissions from these construction sources, expressed as CO_2e emissions, are 99,525 tons.

4.9.5.2 Operation

GHG emissions from proposed Project operations have also been presented in Section 4.9.2.1. A summary of operational GHG emissions by each type of activity is provided in Table 4.9-15. As shown, total GHG emissions, expressed as CO_2e, would be 311,748 tons for the one-time events associated with startup and commissioning of all four FLGNVs, and then 4,958,424 tons per year thereafter once all four FLNGVs were in operation.

Table 4.9-15. Operating GHG Emissions (Four FLNGVs)

Source Category	Emissions (tons per year) CO_2e
Initial startup and commissioning, four FLNGVs	167,832
First-year liquefaction train restart events, four FLNGVs	143,916
Total, One-Time Operating Events	**311,748**
Routine Operation, four FLNGVs	4,831,152
Liquefaction train restart events, four FLNGVs	70,000
Heavy weather operation, four FLNGVs	2,933
Mobile source operation, four FLNGVs	54,339
Total, Ongoing Operating Events	**4,958,424**

4.9.5.3 Decommissioning

GHG emissions from decommissioning would be similar to those from the proposed Port construction. Proposed decommissioning actions would burn fossil fuel in various types of engines and equipment and produce CO_2 and N_2O from the fossil fuel combustion.

extraction to final combustion. NETL concluded that exporting U.S. LNG to produce power in Europe and Asia will not increase greenhouse-gas emissions compared to regional coal power, and that potential differences in greenhouse-gas emissions relating to the use of U.S. LNG, regional LNG, or Russian gas are largely limited to "transport distance" and are otherwise "indeterminate" due to uncertainty in the modeling data. Additionally, NETL concluded that no significant increase or decrease in net climate impact is anticipated from any of these scenarios (see NETL 2014, p. 18). Because NETL analyzed representative approaches for U.S. LNG exports, the general conclusions regarding GHG emissions from such exports are expected to apply to this Project.

4.9.5.4 Effects of Future Climate Change on Project Impacts

In May 2014, the U.S. Global Change Research Program (USGCRP) issued a report, *Climate Change Impacts in the United States: The Third National Climate Assessment*, summarizing the impacts that climate change has already had on the United States and what projected impacts climate change may have in the future (USGCRP 2014). The report includes a breakdown of overall impacts by resource and impacts described for various regions of the United States. Although climate change is a global concern, for this cumulative analysis, we focus on the potential cumulative impacts of climate change in the vicinity of the proposed offshore Project components.

The USGCRP's report, also simply referred to as the National Climate Assessment, makes projections for potential climate change in the Southeast region of the United States, the following of which could affect the offshore Project location during its expected lifetime:

- Changes in precipitation patterns are expected. During the expected Project lifetime, the National Climate Assessment projects overall drier conditions in southwest Louisiana compared to the historical climate. Despite this overall decrease in precipitation, the frequency of extreme precipitation events is expected to increase.
- Tropical storms and hurricanes are expected to become less frequent overall, but the frequency of intense hurricanes (category 4 or 5) is expected to increase.

These projected climate change effects in the vicinity of the proposed offshore Project components are not anticipated to exacerbate any other environmental impacts from the Project during its expected lifetime.

4.9.6 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.9.6.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore air quality.

4.9.6.2 Alternative Deepwater Port Designs

Delfin LNG considered two alternative locations for installation of the four TYMS and pipeline laterals. These two alternative locations met the proposed Project's required criteria for connecting to an existing pipeline of sufficient capacity, for appropriate range of water depth, for acceptable distance from Henry Hub, and for reasonable proximity to a shipping fairway. Delfin LNG also considered reuse of the existing manifold platform at WC 167 as an alternative to constructing a new bypass around it.

Of the three alternative locations for the TYMS and pipeline laterals, Alternatives 2 and 3 are approximately 10 to 15 nautical miles farther offshore from the Applicant's proposed alternative used as the basis for emissions in this final EIS. Construction emissions would be essentially identical for either location, as the same vessels and techniques would be used. Operating emissions would be slightly higher at the second alternative location, due to the farther travel distance to and from shore for support vessels and helicopter flights. While air quality impacts at onshore locations would be slightly lower for the second alternative location, the difference would be negligible since both alternative sites are far from shore.

Construction emissions for reuse of the existing manifold platform at WC 167 would not be significantly different than the Applicant's proposed alternative of constructing a new bypass, since the existing platform would require replacing portions of the existing piping and instrumentation, in order to make it suitable for use with the proposed Project. Operating emissions at the proposed DOF would be slightly lower with the Applicant's proposed bypass alternative, as the more efficient design would result in lower pipeline pressure losses and reduced compressor power required onshore.

4.9.6.3 Alternative Cooling Media

Delfin LNG considered several alternatives for process cooling on the FLNGVs, including closed-loop water cooling, open-loop water cooling, and air-cooled heat exchangers. Air-cooled heat exchangers were selected as the Applicant's proposed alternative, and would result in slightly increased air emissions due to the higher power requirement as compared to water cooling. However, the difference in emissions would be negligible compared to the overall potential emissions from the proposed Project.

4.9.6.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore noise associated with use of this alternative as the extent of construction would be reduced. Impacts on offshore air quality during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.9.6.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Engineering at each of the alternative locations would be the same. Therefore, it could be expected that air emissions and noise from construction of the proposed Project and operation of the FLNGVs would be the same for all locations. Because Alternatives 2 and 3 are 10 nautical miles farther offshore from Alternative 1, it is likely that additional compression would be required at the compressor station. Additional compression would result in additional noise and additional air emissions.

4.9.6.6 Alternative Anchoring Methods

Delfin LNG considered several alternative methods for anchoring the TYMS to the seabed, including grouted piles, suction piles, driven piles, gravity anchors, and embedment anchors. Construction air emissions would not be significantly different for any of the alternative anchoring methods considered.

4.9.7 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-34:** Delfin LNG will minimize fugitive emissions through proper piping design, good work practices, and the implementation of a LDAR program.
- **BMP-35:** Delfin LNG will minimize air emissions from marine vessels during construction through the operation and maintenance of vessels' engines in accordance with manufacturer recommendations. Delfin LNG will maintain and operate engines in accordance with recommended manufacturer operation and maintenance procedures.
- **BMP-36:** Delfin LNG will install turbines for use aboard the FLNGVs equipped with dry low NOx burners to minimize emissions of NO_x.
- **BMP-37:** Delfin LNG will minimize emissions of all other pollutants from the turbines through firing with natural gas during routine operations, use of low sulfur fuel, and implementation of good combustion practices. Delfin LNG will be in compliance with USEPA and North American Emission Control Area requirements, as well as New Source Performance Standards Subpart IIII to minimize air emission from the emergency generator and fire pump engines aboard the proposed FLNGVs.
- **BMP-38:** Delfin LNG will minimize emissions from acid gas thermal oxidizers through the use of low NO_x burners, natural gas fuel, and good combustion practices.
- **BMP-39:** Delfin LNG will minimize emissions of all pollutants from the proposed FLNGVs' flares through the use of good combustion practices.
- **BMP-40:** Delfin LNG will limit GHG and fugitive emissions through the use of BACT controls, including waste heat recovery for the FLNGV power generation turbines, and implementation of a LDAR program. These required air emissions controls will be described in the proposed Project's CAA permit issued by USEPA Region 6.
- **BMP-41:** Delfin LNG will minimize fugitive emissions through proper piping design, good work practices, and the implementation of a LDAR program. Delfin LNG will further limit GHG emissions through the use of BACT controls, including waste heat recovery for the FLNGV power generation turbines. These required air emissions controls will be described in the proposed Project's CAA permit issued by USEPA Region 6.

4.9.8 Recommendations and Conclusions

Impacts on air resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified in Section 4.9.7, we have determined impacts would be as described in Table 4.9-16.

Table 4.9-16. Summary of Impacts for Offshore Air Quality

Aspects of Proposed Action With Potential to Affect Resource	Amount/ Frequency	Applicable Best Management Practices	Severity of Effect
Construction			
Construction of the mooring platforms, pipeline laterals, and WC 167 bypass	Intermittent periods from 2017-2022	BMP-34	Short-term, minor, adverse
Operation			
Initial startup and commissioning of the FLNGVs	One FLNGV per year in 2019-2022	BMP-35 through BMP-41	Negligible
First-year liquefaction train restart events of the four FLNGVs	One FLNGV per year in 2019-2022	BMP-35 through BMP-41	Negligible
Liquefaction train restart events of the four FLNGVs	During port operation	BMP-35 through BMP-41	Long-term, minor, adverse
Routine operational emissions	During port operation	BMP-35 through BMP-41	Long-term, minor, adverse
Heavy weather operations	Up to once per year during port operation	BMP-35 through BMP-41	Negligible
Mobile source operations	During port operation	BMP-35 through BMP-41	Long-term, minor, adverse
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on offshore air quality would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.10 Offshore Noise

Activities associated with construction and operation of the proposed Project that would impact offshore noise include the following:

- airborne construction and operational noise,
- underwater construction and operational noise,
- continuous noise,
- thruster noise,
- pulsive sounds, and
- operational noise associated with support and maintenance vessels and helicopters.

The noise consequences of the proposed DOF are discussed in Section 4.17.

4.10.1 Impacts of Construction

Sources of construction noise associated with the proposed Project include pile installation (i.e., impact pile driving), pipeline installation, and construction vessel transit. Airborne and underwater noise resulting from each of these construction activities associated with the proposed Project are discussed in the following subsections.

As part of the proposed Project, a mooring system would be required to allow permanent mooring of each FLNGV. The installation of each mooring structure would require the installation of four driven piles (approximately 78 inches in diameter by 300 ft in length, subject to change during detailed engineering design), one in each leg. It is anticipated that these piles would be cylindrical steel piles to be driven by hydraulic or steam hammer to desired depth and then the remainder of the pile would be cut off. The airborne SPL for a pile-driver operation is 101 dBA at 50 ft. Construction workers on board the installation vessels would be required to wear hearing protection during pile driving activities. Offshore recreational boaters and fishermen that travel near the construction site could be exposed to construction noise. However, given the temporary nature of construction events and the implementation of a Safety Zone to keep non-Project-related vessels away from the FLNGVs, noise impacts would be short-term and minor. Given the distance from the mooring location to the nearest NSAs onshore (42 miles), there would be no noise impact during construction of the mooring.

Operation of internal combustion engines used to power barges and service vessels and pile driving would be among the most prevalent noise sources during installation. Operation of the diesel engines aboard installation equipment is anticipated to produce noise levels similar to those produced by diesel engine-powered construction equipment used on land, for which typical noise levels are available. The intermittent, short-term nature of construction noise and the distance between potential sound sensitive sites in Cameron Parish, Louisiana and the proposed construction area indicate that impacts from construction noise would be minimal. Table 4.10-1 lists primary noise sources and provides estimated noise levels at various distances from the installation activity.

Except for limited support vessel activity near shore, airborne noise associated with installation of the proposed Project would be confined to areas approximately 24.7 nautical miles (28.4 statute miles) at WC 167 and 37.4 to 40.8 nautical miles (or 43 to 47 statute miles) at the proposed Port and would not affect NSAs onshore. Nearshore vessel activity would produce typical vessel sounds due to engine operation only. No construction equipment for offshore activities would be used for onshore or nearshore construction. Due to the distances involved, airborne noise levels resulting from the construction and operation of the proposed Project would not exceed the USEPA day-night sound level (L_{dn}) limit of 55 dBA, above which interference and annoyance could occur outdoors in residential areas. Construction noise impacts would be temporary and would have a negligible effect on sound levels in the vicinity of construction activities.

Table 4.10-1. Airborne Noise Sources during Construction

Source	SPL a/	Distance/SPL (dBA)			
		500 feet	1,000 feet	2,500 feet	1 mile
Derrick barge main engine	90	46.4	40.4	32.4	25.9
Material barge main engine	90	46.4	40.4	32.4	25.9
Quarters barge main engine	90	46.4	40.4	32.4	25.9
Work boat main engine	90	46.4	40.4	32.4	25.9
Crew boat main engine	90	46.4	40.4	32.4	25.9
Derrick barge crane engine	85	41.4	35.4	27.4	20.9
Derrick barge bow thrusters	85	41.4	35.4	27.4	20.9
Vessel generator engines b/	82	38.4	32.4	24.4	17.9
Pile hammer	100	56.4	50.4	42.4	35.9
Worst case/all equipment	102	58.4	52.4	44.4	37.9

Notes:
a/ Sound pressure level at 1 meter
b/ Based on 250-horsepower engine
Key:
SPL = sound pressure level
dBA = A-weighted decibels

4.10.1.1 Airborne Construction Noise Impacts

Construction noise impacts would be temporary and would have a negligible effect on sound levels in the vicinity of construction activities. Given the distance from the mooring location to the nearest NSAs onshore (42 miles), there would be no airborne noise impact during construction of the mooring.

Construction noise impacts along the existing UTOS/HIOS pipeline system would vary with activity and distance from shore, but would be temporary at any location as the construction operations move along the existing UTOS/HIOS pipeline system. Airborne noise associated with construction activities that are within hearing distance of onshore receptors would be similar to and consistent with the noise already generated by regional vessel traffic and standard onshore-offshore construction noise.

During construction, operating barges, tugs, and large diesel engine support vessels are expected to be dominant noise sources. Temporary noise would be produced by diesel powered construction cranes, compressors, generators, welding machines, and other miscellaneous tools. Table 4.10-1 lists the offshore construction equipment and the corresponding sound pressure level that would be expected at 1 mile away.

4.10.1.2 Underwater Construction Noise Impacts

Continuous Noise

The sources of continuous noise associated with the proposed Project would be vessel transits between the Gulf of Mexico shipping lanes, and noises generated at the loading Port terminal. While ships are moored at the proposed Port, main engines would not be operational, but shipboard machinery used to offload LNG, generate power, and maintain facilities would represent continuous sources of noise. During construction, vessel traffic would be a relatively continuous but transient source of noise. Most vessel noise would be created by propeller cavitations, with dominant tones arising from the propeller blade rate, and would vary with vessel speed. Broadband source levels for most small ships are approximately 170 to 180 dB re 1 μPa, but can be decreased by the use of nozzles or cowlings around the propeller (USCG 2006d). When DP thrusters are used, predicted source levels may reach 186 dB. The use of supply vessels and construction tools would create an additional source of intermittent, transient noise in the water.

Calculations developed by Delfin LNG show that, for a single large container vessel, attenuation to 150 dB would occur approximately 3 miles from the proposed Project location. Importantly, this calculation only considered a single vessel and did not consider other traffic. Shipping traffic for large vessels (≥30 to 32 ft draft) traveling to and from the Port of Port Arthur (i.e., Sabine Pass Channel) was approximately 740 for calendar year (CY) 2013. This suggests that noise from large vessels would be steady within the SPSF. Importantly, this does not take into consideration smaller vessel (less than 30 ft draft) traffic near the proposed terminal. For CY 2013, several thousand smaller vessels were reported as using the channel into the port. A noise survey was conducted on January 13, 2015.

Peak spectral levels for individual commercial ships are in the frequency band of 10 to 50 Hz and range from 195 dB re μPa^2 / Hz @ 1 m for fast-moving (>20 knots) supertankers, with lower levels of approximately 140 dB re μPa^2 / Hz @ 1 m for small fishing vessels (NRC 2003a).

See Sections 4.3 and 4.4 for descriptions of noise impacts on marine species.

Pulsive Sounds

The pulsive sounds expected during construction scenarios are much less intense than the pulses from the air guns used in Gulf of Mexico offshore seismic surveys by the oil and gas industry. Such surveys routinely have source levels of 250 dB re 1 μPa at 1 m. It is highly unlikely that the low levels of pulsed noise from construction activities would have any permanent effects on marine mammals or sea turtles in the proposed Project area. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4.

As part of the proposed Project, four mooring platforms would be constructed to allow permanent mooring of each FLNGV. Construction of each TYMS would involve jacket and pilings installation. First, a derrick barge would mobilize to the TYMS site. Prior to setting the anchors, all pipelines in the immediate area would be located and marked. The tugs would set the derrick barge anchors to secure it to the location. Anchors would be placed using established safety zones from existing pipelines, including HIOS and the newly installed laterals.

The jacket structure and piling would be transported to the proposed Project site in a vertical configuration on a material barge towed by a tug. The jacket barge would moor to the side of the derrick barge. If the lifting slings were not preinstalled on the jacket at the fabrication yard, they would be installed at this time. The lifting slings would be engaged by the lifting block of the derrick barge, and the seafastening connecting the jacket to the barge would be cut, freeing the jacket to be lifted. The jacket would be lifted from the material barge and placed in the water resting on the seafloor at the predesignated location. A tubular cofferdam with bubbles may be used around the pile to as noise reduction system. Additional details on the cofferdam noise mitigation system are contained within Appendix P.

Each TYMS platform would require four pilings to be installed in sections. Each pile section would be driven to grade by a steam or hydraulic pile-driving hammer. The decision to use either a steam or hydraulic hammer would be based on both the pile driving energy required and the installation contractor's equipment and preferences. The energy required to drive the pile would be determined based on a drivability evaluation using the results from the site geotechnical investigation report. As currently planned, the piles would be 300-ft-long (in total), 78-inch-diameter steel piles. Each 300-ft pile would consist of four sections: Section P1 would be 140 ft, P2 55 ft, P3 55 ft, and P4 50 ft. After each section is driven, the next section would be welded to the preceding one, the weld tested for integrity, and then driven to grade. Currently, it is estimated that each pile would require one to one and a half days for installation (including welding, fit-up, and pile handling), for a total of 4 to 6 days for each TYMS platform, with an estimated 3,600 strikes per day. After the total pile installation is complete, the top of each pile would be welded to the top of the jacket leg utilizing a connection device. After the piling installation is completed, the tops of the piles would be cut to the pre-designated elevation and angle.

The only source of high levels of pulsed noise during the construction period would be pile driving. Pile driving would occur for a total of 16 piles at the four TYMS mooring points, for the overall Project. During the first phase, however, only one TYMS would be installed. Piles would be driven one at a time and each pile is expected to take about 1.5 days to complete (working 24 hours per day), which is about 6 days for this phase of the proposed Project. Pile-driving noise would not be continuous because there would be regular stoppages for pile handing, adjustments, and welding of each pile section before driving could either begin or continue. In addition, there may be downtimes due to weather, crew changes, maintenance, and repositioning of the piling barge.

See Sections 4.3 and 4.4 for descriptions of noise impacts on marine species.

4.10.2 Impacts of Operation

Operational activities include those associated with FLNGV transiting, as well as vessel and helicopter activities related to maintenance. Underwater noise is anticipated to be produced by the FLNGVs during the approach, mooring, and offloading activities. A standby support vessel would also be located in close proximity to the FLNGVs during mooring and offloading activities. The highest energy source of underwater sound during the operation phase would be from vessel transits near the proposed Port and from mooring activities. Vessel sounds during operations would result from propeller cavitation and propulsion, in addition to flow noise from water dragging across the hull and bubbles breaking in the wake. The dominant sound source from vessels is propeller cavitation with noise intensity dependent upon size and speed of the vessel. Both airborne and underwater operational acoustic impacts are presented in the following sections. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4.

4.10.2.1 Operation Activities

Supply Vessels and Tugboats

Service vessels and helicopters would be the primary modes for transporting personnel and supplies between service bases and offshore FLNGVs. Sound generated from service vessel traffic would be transient. The intensity and frequency of the noise emissions would be highly variable, both between and among these sources. The proposed Port would require approximately one supply vessel sailing per week to service all four FLNGVs. Offloading operations typically would require four tugboats for each LNGC berthing and also for departure. Noise associated with supply vessels and tugboats offshore would be diminished over distance to any onshore noise-sensitive receptors. In addition, ports are typically located in port/industrial areas where vessel and mechanical noises do not normally affect the community. Most high-speed vessel operations would occur well offshore and would have little impact on noise levels at onshore locations.

Helicopter

The proposed Port would require one regular flight per week to service all four FLNGVs. Additional flights would periodically be required when service technicians/campaign maintenance personnel need to stay on-board for only one to two days. Helicopter sounds contain dominant tones (resulting from rotors) generally below 500 Hertz. The altitude of the helicopter strongly influences noise levels at surface receptors. Because of noise concerns, the FAA regulates helicopter flight patterns. FAA Circular 91-36C encourages pilots to maintain higher-than-minimum altitudes near noise-sensitive areas. Helicopters would likely not pass over deeper water whale habitat, as they would likely come from shore over shallower waters and then would return to shore from the proposed Port site without reaching waters deeper than 590 ft (180 m) where, for example, sperm whales are known to occur (MMS 2006).

FLNGV Operation

The FLNGV would use power-generating equipment, pumps, compressors, and other rotating equipment that create noise. Sound power levels and sound pressure levels at various distances are listed in Table 4.10-2 for the major noise-producing equipment during operation of the FLNGV. The sound levels at 1,000 ft, 1 mile, and 10 miles reflect attenuation of sound over distance due to hemispherical spreading. As indicated in the table, noise generated by the proposed Project would not affect NSAs onshore due to the distance from the terminal to shore.

Table 4.10-2. Floating Liquefied Natural Gas Vessel Noise during Operation

Equipment	Sound Power (LwA)	Distance/SPL (dBA)		
		1,000 feet	1 mile	10 miles
Liquefaction Compressors (3)	106.9	46.9	32.4	12.4
Liquefaction Compressor Exhausts (3)	110.7	50.7	36.2	16.2
Solution Cooler Fan Units	105.0	45.0	30.5	10.5
Cooler Fans	96.3	36.3	21.8	1.8
Steam Generator	106.9	46.9	32.4	12.4
Amine Charge Pumps	104.3	44.3	29.8	9.8
Miscellaneous Pumps	102.4	42.4	27.9	7.9
Instrument Air Package	99.9	39.9	25.4	5.4

Table 4.10-2. Floating Liquefied Natural Gas Vessel Noise during Operation (continued)

Equipment	Sound Power (LwA)	Distance/SPL (dBA)		
		1,000 feet	1 mile	10 miles
Boil-off Gas Compressors (3)	113.7	53.7	39.2	19.2
Boil-off Gas Compressor Motors (3)	109.5	49.5	35.0	15.0
Ammonia Compressor	86.8	26.8	12.3	0.0
Liquefaction Train Piping	118.0	58.0	43.5	23.5

Key:
dBA = A-weighted decibels
LwA = A-weighted sound power
SPL = sound pressure level

4.10.2.2 Airborne Operational Noise Impacts

Section 4.10.2.1 documents all the vessels and helicopters that would create airborne noise during operation of the facility. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4.

Operational airborne noise impacts would be long-term and negligible. Due to the attenuation of noise with distance from noise sources and the distance between sources, no cumulative impacts for noise would occur during operation of the proposed Project. Given the distance from the mooring location to the nearest NSAs onshore (42 miles), there would be no noise impact from noise emanating from the mooring.

4.10.2.3 Underwater Operational Noise Impacts

Continuous Noise

The sources of continuous noise associated with the proposed Project would be support vessel transits between the Gulf of Mexico shipping lanes and noises generated at the loading DWP terminal and other vessel s if used. While ships are moored at the proposed Port, the main engines would not be operational, but shipboard machinery used to offload LNG, generate power, and maintain facilities would represent continuous sources of noise. During routine operations, transient noise would be generated by LNGCs and support vessels.

See Sections 4.3 and 4.4 for descriptions of noise impacts on marine species.

Pulsive Sounds

Pulsive sounds are not expected during operations.

4.10.2.4 Planned and Unplanned Maintenance and Repair

Beyond impacts associated with vessel transits, including intake and discharge of water, and the risk of vessel strike, no adverse noise impacts are expected to occur during planned and unplanned maintenance and repair. Minor repairs would not be expected to increase noise levels by any major amount. The primary source of noise during maintenance and repairs is vessel noise.

According to BOEM, underwater noise from small vessels ranges from 145 to 170 dB at 1 m. According to the USCG, underwater noise associated with vessels with an engine between 1,200 and 6,140 hp ranges from 92 to 112 dB at 1 m (USCG and MARAD 2015). Non-continuous noise associated with small vessel movement and positioning would be below the zone of injury as given in the MMPA for Level A and Level B harassment; therefore, impacts on marine mammals from planned maintenance would be minimized. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4.

Repairs can be either minor or major. Minor repairs are typically shorter in duration and could include replacing faulty pressure transducers, or repairing a stuck valve. These kinds of repairs would require one diver support vessel with three or four anchors to hold its position. Minor repairs could take from a few days to several weeks depending on the nature of the problem.

Major repairs, on the other hand, are longer in duration and typically require large construction vessels similar to those used to install the proposed WC 167 bypass, pipeline laterals and TYMS. These vessels would typically mobilize from local ports. Major repairs typically require upfront planning, equipment procurement, and mobilization of vessels and possibly saturation divers. Examples of major repairs are damage to the proposed WC 167 bypass or pipeline laterals. These types of repairs could take an estimated two to four weeks. A worst-case scenario for noise generated by maintenance and repair activities would be modelled in order to assess impacts. Modeling results would give a representative worst-case scenario of maintenance and repair activities for the proposed Project.

Underwater sound levels from maintenance and repair could cause some marine fauna species to temporarily disperse from or avoid repair areas, but they are expected to return shortly after the completion of repairs. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4. Vessel traffic would be similar to construction as described in Section 4.10.1. It is estimated that the majority of vessel traffic would be within the proposed Port vicinity, with large vessel movement and speed contingent upon the task performed and duration (e.g., proposed WC 167 bypass and pipeline laterals installation). These vessels would most likely mobilize and demobilize once. Crew boats, on the other hand, would operate and transit the site more frequently, depending on duty.

4.10.3 Impacts of Decommissioning

Potential noise impacts associated with proposed Project decommissioning would be expected to be similar to those generated during construction as discussed below.

It is expected the proposed Port would be in operation for at least 30 years. Potential noise impacts would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.

4.10.3.1 Airborne Decommissioning Noise Impacts

Assuming there would be no explosives use, direct impacts on existing sound levels from decommissioning activities would mainly involve vessel engine operation noise. It would be expected that noise impacts from decommissioning would be limited to the immediate vicinity of the proposed Project and would be similar to construction noise. Decommissioning would result in short-term noise due to diesel-powered vehicles, cranes, compressors, generators and other miscellaneous tools. Operational airborne noise impacts would be long-term and negligible. Given the distance from the mooring location to the nearest noise sensitive areas onshore (42 miles), there would be no impact from noise emanating from the mooring.

4.10.3.2 Underwater Decommissioning Noise Impacts

Assuming there would be no explosives use, noise impacts would be limited to decommissioning vessel noise output and noise from helicopters used during this process. Expected noise levels of the decommissioning vessel would be similar to other non-Project vessels that occur regularly in the vicinity during oil and gas operations. Noise impacts on marine mammals and sea turtles would be similar to those discussed from support vessels and helicopters during construction though more short-term. Specific noise-related impact discussions for marine species are provided in Sections 4.3 and 4.4.

4.10.4 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, pipeline routes, port locations, and anchoring systems were evaluated. A No Action Alternative was also evaluated.

4.10.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on offshore noise.

4.10.4.2 Alternative Deepwater Port Designs

Noise impacts for the alternative port designs are similar to those expected with the use of FLNGVs, as is proposed for this Project.

4.10.4.3 Alternative Cooling Media

Noise impacts from either of the two cooling methods would be similarly minor.

4.10.4.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC would not require any greenfield construction; therefore, there would be slightly reduced impacts on offshore noise associated with use of this alternative as the extent of construction would be reduced. Impacts on offshore noise during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.10.4.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). Engineering at each of the alternative locations would be the same. Therefore, it could be expected that air emissions and noise from construction of the proposed Project and operation of the FLNGVs would be the same for all locations. Because Alternatives 2 and 3 are 10 to 15 nautical miles farther offshore from Alternative 1, it is likely that additional compression would be required at the compressor station. Additional compression would result in additional noise and additional air emissions.

4.10.4.6 Alternative Anchoring Methods

The anchoring system must be capable of effectively tethering the FLNGVs under cyclical load changes due to wave, wind, and current loadings. From a noise standpoint, the impact of construction activities on marine mammals is a critical factor in choosing an appropriate anchoring system. Five anchoring alternatives are considered, as follows:

- **Driven piles** are high-grade steel piles driven into the seafloor with hammer blows. The repetitive hammer strikes produce repetitive pulsed noise; therefore, driven piles have the largest noise impact of all anchoring alternatives.
- **Grouted piles** are similar to driven piles, but installed differently. A hole is drilled in the seafloor, the pile is inserted, and grout is pumped in to file the space between the pile and soil/cemented wall. Grouted pile installation results in low to moderate levels of marine noise. The source of noise is primarily the operation of the construction vessel and onboard equipment, including the drill.
- **Suction anchors** consist of a high-grade steel caisson or “upside down bucket” that adheres to the seafloor using negative pressure inside the caisson skirt. This negative pressure is created by pumping water out of the anchor. This alternative would result in low to moderate levels of marine noise, primarily caused by the operation of the construction vessel and onboard equipment such as the pumps used to create the suction necessary for installation.
- **Gravity anchors** are massive concrete objects that rest on the sea floor. Installation of this alternative would result in low to moderate noise impacts, resulting primarily from the operation of the construction vessel as it moves into position and lowers the anchor.
- **Embedment anchors** are dragged across the seafloor until they become embedded in the soil. As with most of these alternatives, the noise impact is primarily caused by the operation of construction vessels.

Driven piles have been chosen as the proposed anchoring method due geophysical conditions in the proposed Project area. Therefore, noise mitigation programs would be required due to the moderate noise impacts caused by hammer strikes.

4.10.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-42:** All Project-related activities will comply with Federal regulations to control noise generated from vessels associated with the proposed Project.
- **BMP-43:** During construction, Delfin LNG will implement various procedure measures, including “soft starts.” Prior to operating at full capacity, Delfin LNG will implement a “soft start” with several initial hammer strikes at less than full capacity (i.e., approximately 40–60 percent energy levels) with no less than a 1-minute interval between each strike.
- **BMP-44:** Delfin LNG will ensure that all equipment has sound control devices no less effective than those provided by the manufacturer.

- **BMP-45:** Standard mitigations for marine mammal monitoring and BMPs will be in place during construction, operation, and decommissioning. Any impacts resulting from Level A or Level B noise will be addressed with an Incidental Harassment Authorization from the Applicant.

4.10.6 Recommendations and Conclusions

Impacts on offshore noise would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.10-3.

Table 4.10-3. Summary of Impacts for Offshore Noise

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Airborne construction noise	Intermittent impacts through the construction period (up to 5.5 years)	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Negligible
Underwater construction noise	Intermittent impacts through the construction period (up to 5.5 years)	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, moderate, adverse
Continuous noise	Intermittent impacts through the construction period (up to 5.5 years)	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Long-term, minor, adverse
Thruster noise	Intermittent impacts during the approximately 21-day pipe laydown period	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, major, adverse
Pulsive sounds	Intermittent impacts during the approximately 6-day pile driving period	BMP-14; BMP-42; BMP-43; BMP-44; BMP-45	Short-term, major, adverse
Operation			
Airborne noise	Intermittent impacts throughout operation	BMP-36; BMP-38; BMP-39	Negligible
Underwater noise	Intermittent impacts throughout operation	BMP-14; BMP-36; BMP-38; BMP-39	Long-term, moderate, adverse
Thruster noise	Intermittent impacts throughout operation	BMP-14; BMP-36; BMP-38; BMP-39	Long-term, minor, adverse
Operational noise associated with support and maintenance vessels and helicopters	Intermittent impacts throughout operation	BMP-14; BMP-36; BMP-38; BMP-39	Negligible
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on the offshore acoustic environment would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

ONSHORE ENVIRONMENTAL CONSEQUENCES

4.11 Onshore Water Resources

Activities associated with construction and operation of the proposed Project that would impact onshore water resources include the following:

- direct filling of wetlands, and
- accidental fuel spills.

4.11.1 Surface Water Resources

The proposed DOF would not cross or impact any freshwater streams or rivers. The alternatives considered also would not cross any waterbody segments. However, impacts on wetland resources were identified with two of the three alternatives.

During construction of the proposed DOF and the new community center in Johnson Bayou, Louisiana, Delfin LNG would adhere to measures described in the Delfin LNG Procedures (Appendix F) and FERC Plan (FERC 2013), and implement its Spill Prevention and Response Plan for Construction (Appendix L) and its SWPPP (Appendix L) to minimize impacts on surface waters.

4.11.2 Wetlands

Wetland impacts during construction would be minimized or avoided in accordance with the DOF Procedures. Associated impacts on wetland resources within the proposed Project footprint are associated with the proposed DOF. Project impacts include the temporary impacts on palustrine emergent (PEM) and palustrine scrub-shrub (PSS) wetlands as part of the expansion of the proposed DOF. Three wetland areas occur on the existing PSI Midstream Partners, L.P. (PSI) Cameron Meadows Gas Plant Site. Total acreage present is estimated to be 4.78 acres. All of these on-site wetlands are at least partially mowed and maintained in an herbaceous state.

4.11.2.1 Construction and Operation Related Impacts to Wetlands

Construction and operation of the proposed DOF would result in temporary impacts on approximately 2.11 acres of PEM wetlands and 0.68 acre of PSS wetlands. Temporary impacts are those associated with short-term activities that may disturb the wetland structure and function present but would be allowed to naturally revegetate and recover. Permanent loss of wetlands by direct filling for new construction and expansion activities would be an estimated 0.12 acre. This permanent loss would be represented by 0.11 acre of PEM and 0.01 acre of PSS. This net loss of wetland acreage would result from construction and operation of the compressor station and pipeline header. These impacts are considered to be moderately adverse and permanent within the direct footprint of the DOF. Wetland losses would be mitigated under the terms of the USACE Section 404 Permit and LDNR Coastal Use Permit. Final mitigation agreements and implementation activities would be developed as part of the USACE and the LDNR permitting processes.

Delfin LNG would minimize impacts to onshore water resources, including wetlands, by locating the new community center on a parcel that would be classified as “uplands” and away from wetland areas to the extent possible. If wetland impacts cannot be avoided, impacts to wetlands should be minimized and fully mitigated per the requirements of the LDNR and USACE.

4.11.3 Groundwater Resources

Within 0.5 mile of the proposed DOF there are a total of 36 active water wells. According to a review of the LDEQ’s Well Protection Program for Cameron Parish, the Cameron Parish Waterworks District 10 does not fall within a drinking water protection area.

4.11.4 Floodplains and Flooding

According to the Federal Emergency Management Agency (FEMA), National Flood Insurance Program Flood Insurance Rate Map (FIRM) for unincorporated areas within Cameron Parish, the proposed DOF would be within a designated FIRM Zone AE, and have the potential for coastal flooding. With an elevation of approximately 14 ft, the entire proposed DOF is classified as having a 1 percent-annual-chance flood. However, the proposed DOF has been historically filled with materials, given the proposed location within the existing PSI Cameron Meadows Gas Plant and Transcontinental Gas Pipe Line Company, LLC (Transco) Station 44 parcels.

Delfin LNG has coordinated with local officials in Cameron Parish, Louisiana, regarding compliance with Executive Order 11988, Floodplain Management, as amended by EO 13690, *Establishing a Federal Flood Risk Management Standard and a Process for Further Soliciting and Considering Stakeholder Input* (see Appendix D). During construction, site grading, soil stabilization, and soil improvement would be used during construction, and the proposed DOF would conform to the applicable floodplain protection standards.

Submarine landslides along the Continental shelf in the Gulf of Mexico are considered the most likely source of tsunami hazards at the proposed DOF as opposed to offshore faults. However, given the long recurrence interval of large submarine slides the relatively short return periods considered (i.e., 100 and 500 years, based on the FEMA guidelines [2007]), it is expected that the tsunami hazard at the site is unlikely.

During two recent hurricane events in 2005 and 2008, the region experienced peak storm surges of 14.9 and 16.5 ft above the North American Vertical Datum of 1988 (NAVD88), respectively (USGS 2005, 2008a). In addition, NOAA models predict the maximum per hour at mean tide could produce a storm surge of up to 21.6 ft above NAVD88. This is above the elevation of the proposed DOF, which is approximately 14 ft. Flooding as a result of sea level rise over a 50-year period is low given relevant data obtained from NOAA Sabine Pass Station 8770570 (NOAA 2015b). According to the data from this station obtained from 1958 to 2013, the mean sea level has risen 5.46 mm per year. This would result in a change in mean sea level by 10.7 inches in 50 years.

The proposed DOF structures have been designed to avoid or minimize the potential impacts of storm surge and/or flooding from periodic hurricanes experienced in the area and to account for sea-level rise risks by being designed at an elevation of greater than 35 ft above mean sea level for the elevated infrastructure (see Section 2.2.8). Buried pipelines and other subsurface infrastructure would not be exposed to direct physical forces of storm surge. The proposed meter stations and appurtenant aboveground facilities would be constructed in accordance with the latest design requirements of the Pipeline and Hazardous Materials Safety Administration regarding severe flooding events.

The new community center in Johnson Bayou, Louisiana, would be elevated per current FEMA requirements and local Cameron Parish building codes. At approximately 85 ft by 85 ft roof area, the new facility is equivalent in size to a small commercial building or a large residence.

4.11.5 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.11.5.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore water resources.

4.11.5.2 Alternative DOF Location

Four separate DOF locations were evaluated as part of the alternative analysis and compared to the proposed DOF location. Results of the evaluation determined that fewer impacts on sensitive natural resources and water quality (e.g., emergent herbaceous wetlands) and maximized use of existing developed properties or agricultural lands was associated with the proposed DOF.

The proposed DOF makes use of existing developed properties with infrastructure consistent with anticipated need and adaptability. This location is strategically positioned to existing onshore gas conveyance systems and is close to existing pipeline infrastructure both onshore and offshore. This location enables the use of an existing footprint for natural gas conveyance offshore and thereby minimizes the environmental impacts for a new footprint in an undeveloped area. Incorporation of the proposed bypass connector allows for the revitalization of existing near and offshore pipeline infrastructure without the need to construct new pipeline infrastructure and thereby abate any additional impacts associated with new pipeline construction.

4.11.5.3 Alternative Compressor Station Design

An alternative compressor station design would not result in a different level of impacts with regard to duration or intensity.

4.11.6 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-46:** During construction and restoration, Delfin LNG will implement Delfin LNG's Procedures (Appendix F) to avoid, minimize, and mitigate potential impacts.
- **BMP-47:** During construction, Delfin LNG will implement its Spill Prevention and Response Plan for Construction (Appendix L) to prevent spills, leaks, and other releases of hazardous materials that could impact onshore water quality. Delfin LNG will also implement its SWPPP (Appendix L) to minimize impacts on surface waters. Delfin LNG will conduct all work in accordance with a Louisiana Pollutant Discharge Elimination System permit for stormwater and industrial waste water and will meet all provisions as provided in LAC 33:IX.2701, et seq.
- **BMP-48:** Delfin LNG will adhere to measures described in the Delfin LNG Procedures (Appendix F) and FERC Plan (FERC 2013). Delfin LNG will work with the USACE and other State and local agencies during the permitting process to ensure wetlands are protected during construction and operation of the proposed Project.
- **BMP-49:** Delfin LNG will minimize impacts to onshore water resources, including wetlands, by locating the new community center on a parcel classified as "uplands" and away from wetland areas to the extent possible. If wetland impacts cannot be avoided, impacts to wetlands will be minimized and fully mitigated per the requirements of the LDNR and USACE.

4.11.7 Recommendations and Conclusions

Onshore impacts would include temporary impacts on approximately 2.11 acres of PEM wetlands and 0.68 acre of PSS wetlands. Temporary impacts are those associated with short-term activities that may disturb the wetland structure and function present. These impacts are not representative of direct losses but reflect temporary disturbance. Mitigation would be required to restore these areas of temporary impacts on conditions reflecting a stable post-construction environmental setting. This restoration activity would require monitoring of the post-construction areas that were restored for several seasons to ensure that wetland functions and values are consistent with the mitigation plan for the area are being fulfilled. In areas of temporary disturbance, seeding and mulching would be used to enhance restoration and recovery. Permanent loss of wetlands by direct filling for new construction and expansion activities would be on an estimated 0.12 acre. This permanent loss would be represented by 0.11 acre of PEM and 0.01 acre of PSS. This net loss of wetland acreage would result from construction and operation of the compressor station and pipeline header. Areas of wetland loss would require mitigation of these losses through wetland creation or existing wetland enhancement or restoration activities. As part of these activities, periodic annual monitoring would be required to monitor recovery and mitigation measure success. Wetland losses would be documented and planned under the terms of the USACE Section 404 Permit and LDNR Coastal Use Permit. Use of the existing compressor station footprint minimized cumulative impacts on wetland resources by preventing the filling and development of properties lacking associated development.

Impacts on onshore water resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.11-1.

Table 4.11-1. Summary of Impacts for Onshore Water Resources

Aspects of Proposed Action With Potential to Affect Resource	Amount/ Frequency	Applicable Best Management Practices	Severity of Effect
Construction			
Direct filling of wetlands	During the two construction periods (13 months, 10 months) temporary fill of 2.11 acres of PEM and 0.68 acres of PSS wetlands	BMP-46	Long-term, minor, adverse
Accidental fuel spills	Unlikely, but possible during 5.5-year construction period	BMP-47	Short-term, minor, adverse
Construction of the new community center	Potential disturbance	BMP-47; BMP-48; BMP-49	Long-term, minor, adverse
Operation			
Permanent fill of wetlands	0.11 acre of PEM and 0.01 acre of PSS wetlands	BMP-48; BMP-49	Long-term, moderate, adverse
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on water resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.12 Onshore Biological Resources

This section addresses potential impacts on onshore biological resources associated with the proposed Project and alternatives. The biological resources potentially affected by the proposed Project are described in Section 3.12 and include terrestrial mammals, avian resources, upland vegetation, and aquatic resources. As discussed in Section 3.12.3, and in accordance with Section 7(c)(1) of the ESA and Section 102 of NEPA, this EIS is serving as the BA for the Proposed Action. Please refer to Section 2.2 for a detailed description of the Proposed Action.

The sections that follow provide impact analyses for Delfin LNG's proposed DOF on onshore biological resources, including terrestrial mammals, avian resources, upland vegetation, and aquatic resources. The section concludes with a comparison of impacts for Delfin LNG's alternative DOF locations and compressor station designs. BMPs are also discussed.

Delfin LNG would minimize impacts to onshore biological resources, including threatened and endangered species, by locating the new community center away from areas that are designated as unique habitat to threatened or endangered species or vital habitat to migratory birds.

4.12.1 Onshore Threatened and Endangered Species

Activities associated with construction and operation of the proposed Project that would impact onshore threatened and endangered mammals and birds include the following:

- ground disturbance,
- vegetation clearing,
- staging activities,
- direct filling of wetlands,
- stormwater runoff,
- construction noise,

- compressor station noise, and
- accidental fuel spills.

As described in Section 4.3, the ESA defines "endangered" as a species in danger of extinction in all or a significant portion of its range. "Threatened" is then defined as a species that is likely to become endangered in the foreseeable future. If a Federal agency undertakes an activity that may impact an "endangered" or "threatened" species, they must first consult with the USFWS or NOAA Fisheries, or both, according to Section 7 of the ESA. Effects, as detailed below, of the proposed Project on the species or its habitat can be direct or immediate (direct effects), or caused by or will result from the proposed action and are later in time (indirect effects), but still reasonably certain to occur (50 CFR 402.02). An effect determination is made for each listed species and designated critical habitat. According to the following determinations:

- No Effect – literally no effect whatsoever to the listed species or designated critical habitat.
- May Affect, Not Likely to Adversely Affect – effects to the listed species or designated critical habitat are insignificant discountable, or wholly beneficial. "Insignificant" impacts are those that do not rise to the level of take. "Discountable" impacts are those that are very unlikely to occur. "Wholly beneficial" effects must have no short- or long-term adverse impacts.
- Likely to Adversely Affect – effects will result in a short- or long-term incidental take of the listed species or designated critical habitat.

This section identifies the activities that may affect, but are not likely to adversely affect (Table 4.12-1), one or more threatened and endangered bird species as defined in Section 3.12.5.1. In a letter dated August 20, 2016, the USFWS concurred with the determination that the proposed onshore activities are not likely to adversely affect Federally listed species and that no further ESA consultation would be necessary for this proposed Project. The activities are presented for the construction, operation, and decommissioning phases of the proposed Project.

Table 4.12-1. Impact Assessment Summary for Federal Threatened and Endangered Species in the Region of Influence (Onshore)

Common Name	Scientific Name	Occurrence in the Proposed Project Area	ESA and MMPA Status	Impact Assessment a/	Impacts of Alternatives a/
Coastal, Marine, and Migratory Birds					
Piping plover b/	*Charadrius melodus*	Potential, Isolated/Seasonal	Threatened	May affect, not likely to adversely affect	May affect, not likely to adversely affect
Red knot	*Calidris canutus rufa*	Potential, Isolated/Seasonal	Threatened	May affect, not likely to adversely affect	May affect, not likely to adversely affect

Notes:
a/ The USCG has concluded that the facilities at the proposed DOF may affect but are not likely to adversely affect these species.
b/ Proposed Project activities may affect but are not likely to adversely affect critical habitat for this species.

4.12.1.1 Threatened and Endangered Birds

The ESA-listed threatened coastal and marine birds, piping plover and red knot, have a low potential to occur in the proposed DOF. Of these two listed species that may occur, the piping plover is more likely to use the proposed DOF site and has critical habitat in close proximity to the proposed DOF. Critical habitat has been designated for the wintering piping plover at various locations along the Louisiana and Alabama Gulf Coast (USFWS 2015c) and occurs within 1 mile of the proposed DOF. The UTOS/HIOS

Pipeline System crosses beneath designated critical habitat for the piping plover is already in place and no additional construction required (see Figure 3.12-1). Impacts on ESA-listed coastal and marine birds would be insignificant and discountable. Therefore, proposed Project construction, operation, and decommissioning actions may affect but are not likely to adversely ESA-listed threatened coastal and marine birds.

Impacts of Construction

Construction of the proposed DOF would cause insignificant impacts on ESA-listed birds. The designated critical habitat for the piping plover is not expected to be impacted or adversely affected by the proposed Project as the Port would use the existing UTOS/HIOS pipeline systems infrastructure (see Section 2.0) without requiring any additional construction in any designated critical habitat for the piping plover. In the onshore and nearshore habitat for the piping plover, impacts from the transit of support vessels during construction and decommissioning and offshore service vessels during construction could contribute to impacts on piping plover. Conservation measures, as described in Section 4.12.7, would be in place to minimize impacts including the following: limiting any beach armoring which can cause loss of intertidal beach habitat where piping plovers feed and roost; leaving any feeding and roosting areas intact; and restricting timing and location of any stabilization projects. Any coastal construction activities, while unlikely to occur, should be scheduled from May to July that would require construction activity in identified primary wintering sites in the vicinity of the proposed DOF; and Delfin LNG would maintain its emergency response plan for oil and chemical spills. Because of the normal coastal or nearshore ranges and habitats required by these birds, no ESA-listed birds are expected to occur near the proposed DOF area though it is possible they could be transient in the offshore areas. With the above mentioned measures in conjunction with the low expectation of occurrence of ESA-listed species, construction of the proposed DOF would cause short-term, adverse, and insignificant impacts on ESA-listed birds such as the plover. Therefore, impacts from construction may affect but are not likely to adversely affect ESA-listed birds.

Impacts of Operation

Operation of the proposed DOF could cause short-term, minor, adverse effects and insignificant and discountable impacts on ESA-listed birds. The proposed DOF has been sited outside of any designated critical habitat for ESA-listed birds, and existing UTOS/HIOS pipeline systems infrastructure will be used. In addition, the proposed DOF is sited within an already industrialized area. Any operational impacts would be insignificant and discountable in comparison to existing conditions. Therefore, impacts from operation may affect but are not likely to adversely affect ESA-listed birds.

Impacts of Decommissioning

Short-term direct minor adverse effects to the marine environment near the proposed Project site, which supports marine biological communities, are expected in connection with decommissioning of the proposed DOF. Decommissioning may involve the removal of all aboveground structures and leaving in place facilities below ground. It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on ESA-listed species would be reassessed prior to decommissioning based on conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

In a letter dated August 20, 2016, the USFWS concurred with the determination that the proposed onshore activities are not likely to adversely affect Federally listed species and that no further ESA consultation would be necessary for this proposed Project.

4.12.2 Terrestrial Mammals (Non-Endangered)

Activities associated with construction and operation of the proposed Project that would impact terrestrial mammals include the following:

- ground disturbance,
- vegetation clearing,
- staging activities,
- direct filling of wetlands,
- stormwater runoff,
- construction noise,
- compressor station noise, and
- accidental fuel spills.

Construction and operation of the proposed DOF may affect terrestrial wildlife; however, overall Project impacts on wildlife are expected to be minor and temporary. Construction of the proposed DOF would primarily result in temporary impacts on industrial and maintained herbaceous land cover within the proposed DOF. Temporary construction impacts would include disturbance and disruption of any wildlife use of the construction work areas, primarily due to construction noise, vegetation clearing, ground disturbance, and staging activities. These disturbances are likely to result in the temporary displacement of wildlife, which would avoid the construction areas and/or the immediately adjacent areas for similar habitats nearby. There is some potential for smaller and less mobile wildlife (e.g., amphibians, reptiles, small mammals, and invertebrates) to be directly affected if they are unable to avoid construction and operations equipment.

Because of the industrialized nature of the existing land cover at the proposed DOF and adjacent land, impacts from operations generally would be unlikely and are not expected to adversely affect local wildlife populations or species. Currently, it is likely that wildlife avoid these properties because of the ongoing activities at the PSI Cameron Meadows Gas Plant and Transco's Station 44. These impacts may extend into adjacent undisturbed habitats that are located to the east and west of the proposed DOF site.

4.12.2.1 Impacts of Construction

In total, 19.36 acres of land would be disturbed during construction. Of the land impacted for construction, the majority consists of maintained herbaceous (6.95 acres [35.9 percent] of the total) and industrial and road (7.17 acres [37.0 percent] of the total). These land covers provide little or no value as vegetation and wildlife habitats. The remaining cover consists of coastal dune shrub thicket (2.04 acres [10.5 percent] of the total), scrub-shrub swamp (0.90 acre [4.6 percent] of the total), and intermediate marsh (2.30 acres [11.9 percent] of the total).

Land used for construction temporary workspace (TWS) that is not required for the operation of the proposed DOF would be restored to pre-existing contours and allowed to revert to previous existing land covers. Construction would cause only a temporary impact on these land covers because they would be allowed to revert to their previous land cover post-construction.

4.12.2.2 Impacts of Operation

For the operation of the compressor station, all areas within the facilities and permanently maintained categories listed in Tables 4.12-2 and 4.12-3 would be permanently converted to industrial land cover, including the following natural land cover types: coastal dune shrub thicket (0.57 acre), scrub-shrub swamp (0.01 acre), and intermediate marsh (0.11 acre). The operational area for the meter station would not disturb any natural communities. The permanent right-of-way along the supply header would be restored to pre-existing contours and allowed to revert to an herbaceous state. Natural community land cover comprising woody vegetation would be permanently converted to an herbaceous state. Along the entirety of the supply header, 0.65 acre of coastal dune shrub thicket would be permanently converted to a maintained herbaceous land cover after construction. Additionally, along the supply header, 0.21 acre of scrub-shrub swamp would be permanently converted to intermediate marsh.

4.12.2.3 Impacts of Decommissioning

Following removal of the equipment and structures, the land would either be put to similar use by another industrial owner or revert to ruderal vegetation and opportunistic species. Impacts of decommissioning would be direct and indirect, short-term and long-term. The area would be converted to another industrial use or revert to ruderal vegetation. The Applicant has no plan to restore wetland habitat affected by the proposed DOF.

An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.12.3 Avian Resources

Activities associated with construction and operation of the proposed Project that would impact onshore avian resources include the following:

- support vessel traffic,
- ground disturbance,
- vegetation clearing,
- staging activities,
- direct filling of wetlands,
- stormwater runoff,
- construction noise,
- compressor station noise, and
- accidental fuel spills.

Migratory birds are expected to occur within the proposed DOF, although natural communities where migratory birds are expected to breed are generally minimal. Migratory birds may nest in man-made and altered habitats such as buildings (e.g., barn swallows) and gravel lots (e.g., killdeer [*Charadrius vociferous*]).

4.12.3.1 Impacts of Construction

Migratory birds may be directly impacted if nests, nestlings, or adults are disturbed during construction, especially during breeding seasons. Impacts may result from construction noise, vegetation clearing, ground disturbance, and staging activities and would be similar to impacts on general wildlife, as described in the sections above.

4.12.3.2 Impacts of Operation

Impacts on migratory birds would be similar to impacts under construction. MBTA birds may be directly impacted if nests, nestlings, or adults are disturbed during operations, especially during breeding seasons. Impacts may result from operation noise and accidental fuel spills, and would be similar to impacts on general wildlife, as described in the sections above.

4.12.3.3 Impacts of Decommissioning

Impacts of decommissioning would be similar to those described for construction, with a short-term or temporary local increase in noise. Following removal of the equipment and structures, the land would either be put to similar use by another industrial owner, or revert to ruderal vegetation and opportunistic species.

An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.12.4 Upland Vegetation

4.12.4.1 Impacts of Construction

Activities associated with construction and operation of the proposed Project that would impact upland vegetation include the following:

- ground disturbance,
- vegetation clearing,
- staging activities,
- stormwater runoff, and
- accidental fuel spills.

Impacts of construction on upland habitat would be direct, long-term, minor, and adverse. Construction of the proposed DOF would disturb or permanently modify 16.16 acres of upland habitat. Upland cover types include maintained herbaceous (6.95 acres) and industrial and road (7.04 acres), as shown in Table 4.12-2 below. None of the upland vegetation types are rare or imperiled.

The permanent right-of-way along the supply header would be restored to pre-existing contours and allowed to revert to an herbaceous state. Natural community land cover comprising woody vegetation would be permanently converted to an herbaceous state. Along the entirety of the supply header, 0.65 acre of coastal dune shrub thicket would be permanently converted to a maintained herbaceous land cover after construction. Additionally, along the supply header, 0.21 acre of scrub-shrub swamp would be permanently converted to intermediate marsh.

Table 4.12-2. Acreage of Upland Vegetation within the Proposed DOF Footprint

Land Cover Classification	Compressor Station (within DOF Fence Line)				Supply Header (outside DOF Fence Line)		Meter Station		Total
	Facilities	Permanently Maintained	ATWS	Supply Header Permanent ROW	Permanent ROW	Construction TWS	Facility	ATWS	
Industrial	1.34	3.42	0.14	0.00	0.46	1.03	0.23	0.42	7.04
Road	0.00	0.00	0.00	0.00	0.03	0.03	0.07	0.00	0.13
Maintained Herbaceous	0.11	1.54	2.14	0.07	0.92	1.62	0.45	0.10	6.95
Coastal Dune Shrub Thicket	0.09	0.48	0.32	0.09	0.56	0.50	0.00	0.00	2.04

Key:
ATWS = additional temporary workspace; ROW = right-of-way; TWS = temporary workspace

Land used for construction TWS that is not required for the operation of the proposed DOF would be restored to pre-existing contours and allowed to revert to previous existing land covers. Construction would cause only a temporary impact on these land covers because they would be allowed to revert to their previous land cover post-construction.

Upon completion of construction, all areas not used for Project operations (i.e., construction work areas and right-of-ways) would be restored and revegetated following guidelines and BMPs in the Delfin LNG Procedures (Appendix F) and the FERC Plan (FERC 2013). The Chinese tallow tree, a noxious weed, would be handled per the Delfin LNG Noxious Plant Control Plan (Appendix M) in order to mitigate the spread of this species at the proposed DOF.

4.12.4.2 Impacts of Operation

Impacts of operation on upland resources would be direct, long-term, minor, and adverse. During operation of the compressor station, all areas within the facilities and permanently maintained categories would be maintained as industrial land cover, including the 0.48 acre of coastal dune shrub thicket converted during construction. The operational phase of the proposed DOF would not disturb any additional upland habitat.

4.12.4.3 Impacts of Decommissioning

Impacts of decommissioning are not known, but it is assumed that the area would be converted to another industrial use or revert to ruderal vegetation. Delfin LNG has no plan to restore native habitat affected by the proposed DOF at the end of its projected life.

An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.12.5 Aquatic Resources

Activities associated with construction and operation of the proposed Project that would impact aquatic resources include the following:

- ground disturbance,
- vegetation clearing,
- staging activities,
- direct filling of wetlands,
- stormwater runoff, and
- accidental fuel spills.

4.12.5.1 Impacts of Construction

Direct Loss of Wetlands

Impacts of construction on aquatic resources would be direct, long-term, minor, and adverse. Construction of the proposed DOF would require that 0.01 acre of scrub/shrub swamp and 0.11 acre of intermediate marsh be permanently converted to developed land. An additional 0.89 acre of swamp and 2.19 acres of intermediate marsh wetland would be affected during construction of the proposed DOF and subsequent operation of the proposed Project (Table 4.12-3).

Table 4.12-3. Acreage of Wetland Vegetation within the Proposed DOF Footprint

Land Cover Classification	Compressor Station (within DOF Fence Line)				Supply Header (outside DOF Fence Line)		Meter Station		Total
	Facilities	Permanently Maintained	ATWS	Supply Header Permanent ROW	Permanent ROW	Construction TWS	Facility	ATWS	
Scrub/Shrub Swamp	0.00	0.01	0.62	0.15	0.06	0.06	0.00	0.00	0.90
Intermediate Marsh	0.00	0.11	2.05	0.04	0.04	0.06	0.00	0.00	2.30

Key:
ATWS = additional temporary workspace; ROW = right-of-way; TWS = temporary workspace

Direct and indirect impacts on aquatic resources would result from (1) changes in the volume and flow of stormwater and (2) small fuel spills (less than or equal to 1 barrel).

Stormwater and Sedimentation

Construction would disturb the soil surface and allow soil to erode. In the absence of any mitigation or control measures, stormwater runoff would enhance erosion and transport sediment from the construction site to areas downgradient. Sediment transported to and deposited in water bodies causes numerous secondary impacts, including (1) increased turbidity, which then reduces light penetration (and thus photosynthesis); (2) increased contaminant loads; (3) introduction of nutrients that can trigger algal blooms; (4) oxygen depletion; (5) smothering demersal eggs; and others. The immediate effect of sedimentation ranges from minor injury to major destruction, depending on the amount of sediment deposited and the area covered. The long-term effect of continued sedimentation is degradation of water quality below levels necessary to support a range of aquatic life other than extremely tolerant species.

Fuel Spills

During construction, unanticipated spills or leaks of fuel during the operation or refueling of vehicles and/or heavy equipment could be detrimental to the water quality of fisheries resources and downstream waterbodies. Reduced water quality could result in adverse effects on local fish species. During construction, Delfin LNG would implement its Spill Prevention and Response Plan for Construction (Appendix L) to prevent spills, leaks, and other releases of hazardous materials that could impact onshore water quality. Delfin LNG would also implement its SWPPP (Appendix L) to minimize impacts on surface waters.

4.12.5.2 Impacts of Operation

Impacts of operation on aquatic resources would be direct, long-term, minor, and adverse. Approximately 0.12 acre of wetland would be impacted by construction and operation of the proposed DOF. During operation of the compressor station, all areas within the facilities and permanently maintained categories would be converted to industrial land cover, including scrub-shrub swamp (0.01 acre), and intermediate marsh (0.11 acre). The operational area for the meter station would not disturb any natural communities.

4.12.5.3 Impacts of Decommissioning

Impacts of decommissioning would be similar to construction in the soils would be disturbed. The proposed Project area would be converted to another industrial use or revert to ruderal vegetation. The Applicant has no plan to restore wetland habitat affected by the proposed DOF.

An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.12.6 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.12.6.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore biological resources, including ESA-listed species.

4.12.6.2 Alternative DOF Location

The alternative DOF locations are not measurably different with regard to stressors for terrestrial wildlife, bird, or ESA-listed species impacts from the proposed DOF; therefore, impacts would be the same.

4.12.6.3 Alternative Compressor Station Design

The compressor station design alternatives would not have appreciably different impacts on upland vegetation or aquatic resources or on terrestrial wildlife, bird, or ESA-listed species than those described for the proposed DOF.

4.12.7 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-50:** Delfin LNG will minimize impacts to onshore biological resources, including threatened and endangered species, by locating the new community center away from areas that are designated as unique habitat to threatened or endangered species or vital habitat to migratory birds.
- **BMP-51:** Delfin LNG will conduct necessary monitoring, reseeding, fertilizing, or other measures needed to re-establish a vegetative cover equivalent to similar adjacent areas.
- **BMP-52:** Delfin LNG will use mechanical control of vegetation in the vicinity of waterbodies and will prohibit the use of herbicides within 100 ft of waterbodies.
- **BMP-53:** Delfin LNG will adhere to the Project-specific Noxious Plant Control Plan (Appendix M). Delfin LNG will handle Chinese tallow tree, a noxious weed, per this plan, in order to mitigate the spread of this disease at the proposed DOF.
- **BMP-54:** Delfin LNG will conduct vegetation clearing and grading activities during the non-breeding season for most avian species (October- February) to the extent practicable. Should grading or clearing activities for the DOF need to be conducted in other months, Delfin LNG will consult with the USFWS in advance to determine appropriate site-specific measures to minimize potential impacts on birds.
- **BMP-55:** To mitigate impacts on vegetation and potential wildlife habitat, Delfin LNG will restore and revegetate all areas not used for DOF operations following the guidelines and BMPs in the FERC Plan and Delfin LNG Procedures. Following construction, Delfin LNG will permanently stabilize disturbed areas within the construction site by covering with crushed rock (or the equivalent) or seeding with a grass that is compatible with the climate and easily maintained. If re-seeding of the construction work areas cannot be completed immediately following construction, Delfin LNG will mulch the disturbed areas and install appropriate erosion-control devices until final restoration and seeding can be completed. Roads and parking areas that may be disturbed by construction will be re-covered with crushed rock, concrete, or asphalt.
- **BMP-56:** Delfin LNG will take all measures possible to minimize the amount of total lighting used on the proposed terminal to that required for safety. Additionally, the amount of light will be minimized during the height of the trans-migratory period for bird species. To reduce the disruptive effects of lighting, all lighting at the terminal will be downshielded to keep the dispersion of light to a minimum. The shields will prevent the lights from shining skyward, instead directing the light to shine only on work areas. Shielded lighting has resulted in significant reductions in bird mortality (Evans Ogden 2002; Orr et al. 2013). A heliport is planned for the proposed Project's FLNGVs; Delfin LNG will install lighting on the heliport in accordance with USFWS guidelines for aviation safety lights. These guidelines specify that only white or red strobe lights should be used at night and that these strobes should be minimal in number, intensity, and number of flashes.

4.12.8 Recommendations and Conclusions

Impacts on onshore biological resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.12-4.

Table 4.12-4. Summary of Impacts for Biological Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of new community center	Disturbance of 1.2-2 acres	BMP-50	Negligible
Terrestrial Mammals			
Ground disturbance	19.36 acres during the two construction periods (13 months, 10 months)	BMP-51; BMP-54; BMP-55	Negligible
Vegetation clearing	5.24 acres during the two construction periods (13 months, 10 months)	BMP-51; BMP-54; BMP-55	Negligible
Staging activities	Intermittent during the 5.5-year construction period	BMP-51; BMP-55	Negligible
Direct filling of wetlands	During the two construction periods (13 months, 10 months)	BMP-46; BMP-47; BMP-48, BMP-54;	Long-term, minor, adverse
Stormwater runoff	During the two construction periods (13 months, 10 months)	BMP-47	Negligible
Fuel spills	Accidental during the two construction periods (13 months, 10 months)	BMP-47	Negligible
Construction noise	During the two construction periods (13 months, 10 months)	BMP-68; BMP-69	Short-term, minor, adverse
Onshore Avian Resources			
Support vessel traffic	During the two construction periods (13 months, 10 months)	BMP-24; BMP-25; BMP-26; BMP-27	Negligible
Ground disturbance	19.36 acres during the two construction periods (13 months, 10 months)	BMP-43; BMP-46; BMP-47	Negligible
Vegetation clearing	5.24 acres during the two construction periods (13 months, 10 months)	BMP-43; BMP-46; BMP-47	Negligible
Staging activities	Intermittent during the 5.5-year construction period	BMP-43; BMP-47	Negligible
Direct filling of wetlands	During the two construction periods (13 months, 10 months)	BMP-40; BMP-41; BMP-42, BMP-44;	Long-term, minor, adverse
Stormwater runoff	During the two construction periods (13 months, 10 months)	BMP-41	Negligible
Fuel spills	Accidental during the two construction periods (13 months, 10 months)	BMP-41	Negligible
Construction noise	During the two construction periods (13 months, 10 months)	BMP-58; BMP-59; BMP-60	Short-term, minor, adverse
Upland Vegetation			
Ground disturbance	19.36 acres during the two construction periods (13 months, 10 months)	BMP-43; BMP-46; BMP-47	Negligible

Table 4.12-4. Summary of Impacts for Biological Resources (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Vegetation clearing	5.24 acres during the two construction periods (13 months, 10 months)	BMP-42; BMP-43; BMP-46; BMP-45; BMP-47	Negligible
Staging activities	Intermittent during the 5.5-year construction period	BMP-43; BMP-47	Negligible
Stormwater runoff	During the two construction periods (13 months, 10 months)	BMP-41	Negligible
Fuel spills	Accidental during the two construction periods (13 months, 10 months)	BMP-41	Negligible
Aquatic Resources			
Ground disturbance	19.36 acres during the two construction periods (13 months, 10 months)	BMP-40; BMP-41; BMP-42; BMP-44	Negligible
Vegetation clearing	5.24 acres during the two construction periods (13 months, 10 months)	BMP-42; BMP-43; BMP-44; BMP-46; BMP-45; BMP-47	Negligible
Staging activities	Intermittent during the 5.5-year construction period	BMP-43; BMP-47	Negligible
Direct filling of wetlands	During the two construction periods (13 months, 10 months)	BMP-40; BMP-41; BMP-42, BMP-44;	Long-term, minor, adverse
Stormwater runoff	During the two construction periods (13 months, 10 months)	BMP-41	Negligible
Fuel spills	Accidental during the two construction periods (13 months, 10 months)	BMP-41	Negligible
Operation			
Terrestrial Mammals			
Fuel spills	Accidental during operation of DOF	BMP-41	Negligible
Compressor station noise	During the operation of DOF	BMP-59; BMP-60	Negligible
Onshore Avian Resources			
Fuel spills	Accidental during operation of DOF	BMP-41	Negligible
Compressor station noise	During the operation of DOF	BMP-59; BMP-60	Negligible
Gas flaring	Intermittent during port operation, as needed for safety	BMP-19	Negligible
Upland Vegetation			
Fuel spills	Accidental during operation of DOF	BMP-41	Negligible
Aquatic Resources			
Fuel spills	Accidental during operation of DOF	BMP-41	Negligible
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on biological resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.13 Onshore Geological Resources

This section identifies how the geologic conditions, specifically geologic and soil features (geologic conditions, soil characteristics, geologic hazards, and mineral resources) defined in Section 3.3.4 in the onshore environment, may affect or be affected by construction, operation and/or decommissioning of the proposed DOF and alternatives. Protection of unique geological features, minimization of soil erosion, and the location of facilities in relation to mineral resources and potential geologic hazards, such as seismicity and sinkholes, were considered when evaluating the potential geological impacts of the proposed DOF. Generally, impacts on geologic resources or impacts caused by geologic hazards can be avoided or minimized through proper siting, foundation, and structural engineering design and construction, operation, and decommissioning techniques.

Activities associated with construction and operation of the proposed Project that would impact onshore geological resources include the following:

- construction of proposed DOF, including associated pipelines; and
- routine landscape management around the proposed DOF.

Geologic and soil resources generally would not be affected by the proposed DOF. Some short-term disturbance of soils would be expected during construction and decommissioning, and negligible disturbance during operations. The entirety of the proposed DOF facilities and associated temporary construction activities would be located within the boundaries of existing rights-of-way on land already devoted to energy infrastructure use. Construction, operation, and decommissioning of the proposed Project would not be expected to impact any mineral or paleontological resources, increase the risk associated with any geological hazards (landslides, seismicity, and liquefaction), or alter soil composition or structure.

Subsidence due to compaction, settlement, and shearing of the soils under the proposed DOF is a potential occurrence and will be taken into consideration during facility design. The Applicant will follow the recommendations of the FERC Plan (2013) and the Project-specific Delfin LNG Procedures to mitigate localized slope failure hazards (Appendix F).

The proposed elevation of +35 ft above mean sea level for the elevated proposed DOF infrastructure is designed to avoid or minimize the potential impacts of storm surge and/or flooding from periodic hurricanes experienced in the area and to account for sea-level rise risks. Buried pipelines and other subsurface infrastructure would not be exposed to direct physical forces of storm surge. Meter stations and appurtenant aboveground facilities would be constructed in accordance with the latest design requirements of the PHMSA regarding severe flooding events.

4.13.1 Impacts of Construction

Minor, adverse impacts on geology and soils would be expected during the construction of onshore facilities. Construction of the proposed DOF would disturb or permanently modify 19.36 acres of land. Construction and operations would impact 6.34 acres of prime farmland soils. These soils are not being used for agricultural purposes, so croplands would not be impacted. As the proposed Project would be located and operated on previously developed industrial areas, no impacts on prime farmlands are expected and the proposed Project is exempt from the Farmland Protection Policy Act per the NRCS.

Disturbance of soils during construction of the proposed DOF would result in increased potential for erosion, compaction, and mixing of topsoil. Installing pilings for the elevated structures could disturb soil profiles by bringing subsoils to the ground surface. The proposed DOF site has a low susceptibly to erosion impacts and has a moderate to good revegetation potential for grassy habitats.

To limit the effects of erosion, the Applicant would implement the FERC Plan (FERC 2013) and the Project-specific Delfin LNG Procedures (Appendix F). Appropriate erosion and sedimentation control measures, (e.g., silt fencing) would be implemented and maintained at all times during construction of the proposed DOF until revegetation occurs, as required by the FERC Plan. Following restoration and cleanup, the disturbed areas would be monitored to maintain erosion control structures and to repair any erosion.

Compaction mitigation measures, such as surficial tilling in preparation for reseeding, would be used as needed to ensure revegetation of grassy habitats, as applicable in the non-infrastructure areas of the facility, to control erosion and run-off. Following restoration and cleanup, the disturbed areas, including areas of prime farmland soils, would be monitored to maintain erosion control structures and to repair any erosion.

4.13.2 Impacts of Operation

Operation of the proposed DOF would not involve land-disturbing activities other than normal landscape management when needed. Therefore, no impacts on geology or soils from operations are expected.

4.13.3 Impacts of Decommissioning

Minor, adverse impacts on geology soils would be expected during the demolition of onshore facilities as a result of ground disturbance associated with equipment and structure removal, similar to that of construction.

It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on geologic and soil resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.13.4 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.13.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore geological resources.

Alternative DOF Location

Alternative #1 and #2 DOF locations would have similar impacts on geologic and soil resources from the proposed DOF; therefore, impacts would be the same. Alternative #3 or Alternative #4 would result in greater impacts on geologic and soil resources as a portion is proposed on undeveloped lands.

Alternative Compressor Station Design

The compressor station design alternatives would not have appreciably different impacts on geologic or soil resources than those described for the proposed DOF.

4.13.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-57:** Delfin LNG will follow the recommendations of the FERC Plan (FERC 2013) and Procedures to mitigate localized slope failure hazards.
- **BMP-58:** Should blasting be required for construction of the DOF, Delfin LNG will prepare and submit a blasting plan for FERC review and approval prior to conducting any blasting activities.
- **BMP-59:** Delfin LNG will adhere to the Project-specific FERC Plan (FERC 2013) and the Project-specific Procedures, with regard to the use of appropriate erosion and sedimentation control measures during construction, until revegetation occurs. Following restoration and cleanup, the disturbed areas will be monitored to maintain erosion control structures and to repair any erosion.

4.13.6 Recommendations and Conclusions

Impacts on onshore geologic resources would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.13-1.

Table 4.13-1. Summary of Impacts for Geological Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of DOF, including associated pipelines	Disturbance or permanent modification of 19.36 acres of land	BMP-57; BMP-59	Short-term, minor, adverse
Operation			
Routine landscape management surrounding DOF	Occasionally throughout operation	BMP-59	Long-term, minor, adverse
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on onshore geological resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.14 Onshore Cultural Resources

This section identifies how onshore cultural resources, as described in Section 3.14, may be affected by construction and/or operation of the proposed DOF and alternatives. Cultural resources include archaeological sites (prehistoric and historic; terrestrial and marine), historic standing structures, objects, districts, traditional cultural properties, and other properties that illustrate important aspects of prehistory or history or have important long-standing associations with established communities or social groups.

Activities associated with construction and operation of the proposed Project that would impact onshore cultural resources include the following:

- construction of proposed DOF, including associated pipelines;
- relocation of Johnson Bayou Community Center; and
- alteration of the viewshed (that would be visible from NRHP-eligible or -listed cultural properties of that may be seen from a public right-of-way when viewing a cultural resources that is NRHP-eligible or -listed).

The APE on archaeological resources for the proposed DOF includes all locations that would undergo disturbance due to the proposed Project construction, operation, and decommissioning. In compliance with Section 106 of the NHPA, any project, activity, or program that can result in changes in the character or use of historic properties, if any such historic properties are located in the APE. The project, activity, or program must be under the direct or indirect jurisdiction of a Federal agency, or licensed or assisted by a Federal agency. Undertakings include new and continuing projects, activities, or programs and any of their elements not previously considered under Section 106.

If a Federal agency's action constitutes an undertaking as defined under Section 106 of the NHPA, it has the potential to affect historic properties, the agency determines the scope of appropriate identification efforts and then proceeds to identify historic properties in the APE. The agency reviews background information, consults with the SHPO/THPO and others, seeks information from knowledgeable parties, and conducts additional studies as necessary. See Section 4.6 and Appendix D for USCG correspondence with Federal and State agencies and Native American Tribes.

4.14.1 Impacts of Construction

There is potential to impact onshore cultural resources in the APE as a result of construction of the proposed Project. An archaeological survey report for the proposed Project (Boyko et al. 2015) has been reviewed by USCG, MARAD, and the Louisiana SHPO. The proposed DOF would be located on parcels of land currently used by the PSI Cameron Meadows Gas Plant and Transco's Station 44.

Phase I cultural resources survey and archaeological inventory were performed on two parcels deemed to have potential to contain archaeological resources not previously affected by the existing gas plant or Transco's Station 44. The northern parcel comprises 42.33 acres and a southern parcel 15.06 acres.

The archaeological field survey included both shovel testing and pedestrian survey. The southern parcel contained no previously identified archaeological resources and no new cultural resources were identified within the parcel as a result of the recent survey for the proposed DOF. There would be no adverse impacts on cultural resources that meet the criteria to be eligible for the NRHP from the construction of the proposed DOF.

Shovel testing and pedestrian survey of the northern parcel resulted in the identification of a portion of a previously known archaeological site that was demonstrated to extend into the proposed DOF APE. The site was originally reported in the mid-1970s and contained a variety of projectile point and ceramic types that date to the period of AD 500–1500. When originally reported, the site was not assessed for its potential to be eligible for the NRHP. The site was subsequently revisited in the early 2000s, when over 820 artifacts were recovered and the site was demonstrated to extend to at least 70 cm (21.3 inches) in depth below the ground surface. At that time, the site was noted to have the potential to also contain human remains in addition to the many artifacts that had been recovered. The site is currently recommended by Delfin LNG's contractor as potentially eligible for the NRHP. In September 2016, Delfin LNG's contractor requested a determination of NRHP eligibility for the site from the Louisiana SHPO. On September 27, 2016, the Louisiana SHPO confirmed that a Phase I survey of the proposed new pipeline and laydown yard areas would not be recommended (Appendix D).

Review of the known site information in relation to the proposed DOF footprint indicates that the site is located outside of the currently proposed construction footprint. To ensure that Delfin LNG's activities would not affect the site, Delfin LNG developed a site avoidance plan. During construction, Delfin LNG would demarcate a "no work area" that would serve as a buffer zone around the site boundary. Delfin LNG would place fencing and signage approximately 100 ft (31 m) from the known borders of the site. This would prevent individuals and construction equipment from entering the bounds of the site and would restrict all vehicular traffic to existing roads and facilities within the site boundary. If Delfin LNG determines that it must reduce the extent of the "no work area," Delfin LNG's contractor would perform additional Phase I cultural resources investigations within the area between the existing "no work area" boundary and the newly proposed "no work area" boundary (both located outside of the currently known boundary of the site) to ensure that no cultural deposits would be adversely affected during construction activities. Results of any additional survey would be provided to the USCG, MARAD, FERC, and the Louisiana SHPO for review prior to construction. On September 27, 2016, the Louisiana SHPO provided concurrence that this plan would avoid impacts to the site (Appendix D).

Construction of the new community center in Johnson Bayou, Louisiana, has the potential to adversely impact cultural resources as a result of ground improvement and excavation. Delfin LNG would mitigate the potential for adverse impacts to cultural resources by coordinating potential project sites with the Louisiana SHPO during the site selection process. Delfin LNG's preference would be to avoid sites containing cultural resources recorded by the Louisiana SHPO. If recommended by the Louisiana SHPO, a Phase 1 cultural resource investigation would be conducted prior to final site selection to ensure no impacts to cultural resources. Delfin LNG would also implement its *Unanticipated Discoveries Plan* (Appendix J) should unknown cultural resources be discovered during construction of the community center.

4.14.2 Impacts of Operation

There would be no direct or indirect impacts on cultural resources from the operation of the proposed DOF because no new areas of the APE would be impacted by operational activities.

4.14.3 Impacts of Decommissioning

No impacts on onshore cultural resources would be expected as a result of the decommissioning of the proposed DOF provided that avoidance plans are implemented to avoid all noted NRHP-eligible cultural resources. Any avoidance plan that was implemented during commissioning, should be implemented during decommissioning to assure that no impacts would occur as a result of the DOF.

An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7(b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.14.4 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.14.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore cultural resources.

4.14.4.2 Alternative DOF Location

Four locations met the initial siting criteria for the proposed DOF including proximity to gas supply pipelines, proximity to gas supply header pipelines, and extant natural gas facilities. There are no NRHP properties located within 0.25 mile of Alternatives #1, #2, or #3; however, NRHP data were not provided for Alternative #4 as discussed in Section 2.3.9.

4.14.4.3 Alternative Compressor Station Design

An alternative compressor station design would not result in a different level of impacts with regard to duration or intensity.

4.14.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-60:** If the proposed Project cannot avoid cultural resources identified as potentially eligible for the NRHP, then further investigations will be required to determine if these qualify as historic properties. If the cultural resources are identified as historic properties, an appropriate treatment plan will need to be developed and implemented prior to construction.
- **BMP-61:** Delfin LNG has developed an *Unanticipated Discoveries Plan* for the proposed DOF (Appendix J). This plan was reviewed by MARAD, FERC, and Louisiana SHPO. All proposed Project construction, operation, and decommissioning personnel shall be familiar with the plan and the steps that Delfin LNG has agreed to follow in the event of the discovery of a significant cultural resource including human remains.
- **BMP-62:** Delfin LNG commits to evaluation of the extent of contamination, required avoidance measures and the potential impact on existing cultural resources in developing response measures to any Project-related upsets/accidents involving limited heavy hydrocarbons and debris.
- **BMP-63:** Delfin LNG commits to implementation of a “no work area” as identified in a site avoidance plan for Site 16CM84.
- **BMP-64:** Delfin LNG commits to making reasonable efforts to avoid or minimize damage to cultural resources and to reporting the discovery of any previously unreported cultural resources to FERC and the Louisiana SHPO, as described above. Delfin LNG further commits to preliminary documentation of the cultural resource, avoidance of further damage, and cooperation with FERC and the Louisiana SHPO to develop appropriate plans regarding the discovery.
- **BMP-65:** In the event that human remains are discovered, Delfin LNG commits to stopping work and following the Louisiana State guidelines outlined in the applicable portions of the Unmarked Human Burial Sites Preservation Act (La. R.S. 8:671–681) and the Louisiana Historic Cemetery Preservation Act (La. R.S. 25:931–943).
- **BMP-66:** Delfin LNG will coordinate with the Louisiana SHPO regarding the site selection process for the new community center. If recommended by the Louisiana SHPO, a Phase 1 Cultural Resource investigation will be conducted prior to final site selection to ensure no impacts to cultural resources. Delfin LNG will also implement its *Unanticipated Discoveries Plan* (Appendix J) should unknown cultural resources be discovered during construction of the community center.

4.14.6 Recommendations and Conclusions

After review of Delfin LNG's DWPA Application and Section 7(c) Application, FERC has determined that the following additional recommendations should be implemented in addition to the previously mentioned BMPs to minimize impacts on onshore cultural resources.

- **FERC Rec-12:** Delfin LNG **shall not begin construction** of the DOF facilities and/or use of staging, storage, or temporary work areas and new or to-be-improved access roads **until**:
  - Delfin LNG files with the Secretary:
    - remaining cultural resources survey report(s);
    - determination of whether Delfin LNG would need to reduce the extent of the "no work area" surrounding site 16CM84;
    - site evaluation report(s) and avoidance/treatment plan(s), as required; and
    - comments on the cultural resources reports and plans from the Louisiana SHPO.
  - The Advisory Council on Historic Preservation is afforded an opportunity to comment if historic properties would be adversely affected; and
  - The FERC staff reviews and the Director of OEP approves the cultural resources reports and plans, and notifies Delfin LNG in writing that treatment plans/mitigation measures (including archaeological data recovery) may be implemented and/or construction may proceed.

  All materials filed with the Commission containing **location, character, and ownership information** about cultural resources must have the cover and any relevant pages therein clearly labeled in bold lettering: "**CONTAINS PRIVILEGED INFORMATION - DO NOT RELEASE**."

Based on implementation of the BMPs identified in Section 4.14.5 and the recommendations listed above, we have determined impacts would be as described in Table 4.14-1.

Table 4.14-1. Summary of Impacts for Cultural Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of DOF, including associated pipelines	Disturbance of 42.33 acres	BMP-60; BMP-61; BMP-62; BMP-63; BMP-64; BMP-65 FERC Rec-12	Short-term, moderate, not adverse
Alteration of the viewshed	Temporary presence of vehicles and equipment and land disturbance during construction	None	Negligible
Construction of the new community center	Disturbance of 1.2 to 2 acres	BMP-66	Short-term, minor, adverse
Operation			
There would be no direct or indirect impacts on cultural resources from the operation of the proposed DOF because no new areas of the APE would be impacted by operational activities.			
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on cultural resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.15 Land Use, Onshore Recreation, and Onshore Visual Resources

Land use, recreation, and visual resources impacts could result during the proposed DOF's construction, operation, and decommissioning phases. Activities associated with construction and operation of the proposed Project that would impact land use, recreation, and visual resources include the following:

- construction of proposed DOF, including associated pipelines;
- relocation of Johnson Bayou Community Center;
- temporary presence of construction vehicles;
- alteration of the viewshed; and
- conversion of open lots to industrial use.

4.15.1 Land Uses

Land use would be impacted during construction, operation, and decommissioning, as discussed below.

4.15.1.1 Impacts of Construction

Of the land impacted for construction, the majority consists of maintained herbaceous (6.95 acres [35.9 percent of the total needed]) and industrial and road (7.17 acres [37.0 percent of the total needed]). These types of land cover provide little or no value for vegetation and wildlife habitats. The remaining cover consists of coastal dune shrub thicket (2.04 acres [10.5 percent of the total needed]), scrub/shrub swamp (0.90 acre [4.6 percent of the total needed]), and intermediate marsh (2.30 acres [11.9 percent of the total needed]).

Land used for temporary construction workspaces and not needed for the operation of the proposed DOF would be restored to pre-existing contours and allowed to revert to previous covers. Depending on restoration success, the quality of the habitat also may be impacted.

As discussed in Section 2.2.9, there would be no need for any new or expanded construction, laydown or parking areas to construct the proposed Project. Delfin LNG would use existing Gulf of Mexico fabrication and pipeline yards. The U.S.-based construction associated with the proposed Project would be limited in scope and could be accommodated within the existing permitted footprints of several existing offshore fabrication and pipeline facilities.

Construction of the new community center in Johnson Bayou, Louisiana, would occur on a parcel between 1.2 and 2 acres in size, with the size of the building itself similar to the existing community center (roof dimensions approximately 85 ft by 85 ft). There would be no need for off-site laydown areas because the portion of the parcel designated for parking would be used for temporary storage of materials. The workforce is sufficiently small that worker parking would be accommodated on site.

4.15.1.2 Impacts of Operations

All the ground under the compressor station facilities and areas that would be permanently maintained would be permanently converted to industrial land cover. Natural land covers that would be converted to industrial would be coastal dune shrub thicket (0.57 acre), scrub/shrub thicket (0.01 acre), and intermediate marsh (0.11 acre). The operational area for the meter station would not disturb any natural community land covers. The permanent right-of-way along the supply header would be restored to pre-existing contours and allowed to revert to an herbaceous state. Natural community land covers composed of woody vegetation would be permanently converted to an herbaceous state. Along the entirety of the supply header, 0.65 acre of coastal dune shrub thicket would be permanently converted to a maintained herbaceous land cover after construction. Additionally, along the supply header, 0.21 acre of scrub/shrub swamp would be permanently converted to intermediate marsh.

Upon completion of construction, all areas not used for DOF operations (i.e., construction work areas and right-of-ways) would be restored and revegetated following guidelines and BMPs in the Delfin LNG Procedures (Appendix F) and FERC Plan (FERC 2013). As all lands that would be used for the construction and operation of the proposed DOF are on properties used for natural gas facilities or existing and maintained rights-of-way, the land use of these properties would not change.

Delfin LNG anticipates that the operations staging area would be at an existing facility in the Cameron, Louisiana, vicinity. Delfin LNG has no plans to establish any new facilities or associated parking areas beyond the proposed DOF, to support routine operations at the proposed Port.

4.15.1.3 Impacts of Decommissioning

Potential impacts associated with the decommissioning period would generally be similar to those associated with construction.

It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on land uses would be reassessed prior to decommissioning based on conditions and regulations at that time.

4.15.2 Recreation Resources

Recreation resources would be impacted during construction, operation, and decommissioning, as discussed below.

4.15.2.1 Impacts of Construction

With the exception of the Johnson Bayou Community Center, construction of the proposed DOF would have minimal impact on recreation and recreational sites in the region given the lack of resources and minimal disturbance. The Johnson Bayou Community Center is currently situated within the proposed DOF footprint and would become office space for Delfin LNG. To mitigate this impact, Delfin LNG would replace the community center per an agreement to be reached with Cameron Parish. As discussed in Section 2.2.8.2 of this final EIS, as of September 14, 2016, a location has not been selected nor has any current landowner for a potential new location been contacted in connection with this transaction; however, Delfin LNG intends to locate the new community center near the center of Johnson Bayou, Louisiana, and ideally within 4 miles of the intersection of Gulf Beach Highway and Middle Ridge Road.

4.15.2.2 Impacts of Operations

Impacts to recreation resources would be similarly minimal for operation of the proposed DOF site as would be expected during construction. The Johnson Bayou Community Center would be repurposed as office space; however, Delfin LNG intends to replace the center. As discussed in Section 2.2.8.2 of this final EIS, the new community center would house the same amenities (bathrooms, storage room, kitchen area, oven, refrigerator, small stage, elevator, etc.) as well as improved parking.

4.15.2.3 Impacts of Decommissioning

Impacts to recreation resources would be similarly minimal for decommissioning of the proposed DOF site as would be expected during construction. The Johnson Bayou Community Center could be returned to its original use.

It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on recreational resources would be reassessed prior to decommissioning based on conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7(b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.15.3 Visual Resources

Visual resources would be impacted during construction, operation, and decommissioning, as discussed below.

4.15.3.1 Impacts of Construction

Impacts to visual resources during construction would be attributed to the presence of construction equipment and conversion of open lots to industrial buildings and infrastructure. No trees would be removed, but 2.94 acres of coastal dune shrub thicket and scrub/shrub swamp would be removed during construction. Impacts during construction would be limited in duration to the period of construction and would be minimal due to the presence of large industrial facilities that dominate the surrounding viewshed.

4.15.3.2 Impacts of Operations

Of the 2.94 acres of coastal dune shrub thicket and scrub/shrub swamp that would be impacted during construction, 0.56 acre would be allowed to revert to natural conditions post-construction. During operation and after revegetation, the appearance of the proposed DOF components would be consistent with the existing viewshed in this industrial area; therefore, impacts on visual and aesthetic resources would be long-term but minimal.

4.15.3.3 Impacts of Decommissioning

Potential visual impacts associated with the decommissioning period would generally be similar to those associated with construction. It is assumed that the area would be converted to another industrial use or revert to ruderal vegetation. Following decommissioning, visible components would likely continue to be of an industrial nature, if converted to another industrial use.

It is expected the proposed DOF would be in operation for at least 30 years. Potential visual impacts would be reassessed prior to decommissioning based on conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin submits an application to abandon the natural gas pipeline and ancillary facilities.

4.15.4 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.15.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on land use, onshore recreational resources, or onshore visual resources.

4.15.4.2 Alternative Deepwater Onshore Facilities Locations

With regard to land use, recreation, and visual resources, use of any of these three alternatives, or a combination of the sites, would have similar impacts during construction, operation, and decommissioning. The three sites are previously disturbed by industrial activity; however, exclusive use of Alternative #3 or Alternative #4 would result in greater impacts on undeveloped lands. The PSI Cameron Meadows Gas Plant (Alternative #1) and Transco’s Station 44 (Alternative #2) are currently occupied by oil and gas infrastructure.

4.15.4.3 Alternative Compressor Station Designs

An alternative compressor station design would not result in a different level of impacts with regard to duration or intensity.

4.15.5 Best Management Practices

No mitigation measure or monitoring is recommended, as impacts would be minor. Delfin LNG would replace the Johnson Bayou Community Center, which it intends to use as office space during construction and operation of the proposed Project.

4.15.6 Recommendations and Conclusions

Based on implementation of the BMPs identified above, we have determined impacts would be as described in Table 4.15-1.

Table 4.15-1. Summary of Impacts for Land Use, Onshore Recreation, and Onshore Visual Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction of DOF, including associated pipelines	Permanent modification of 30 acres of land	None	Short-term, minor, adverse
Relocation of Johnson Bayou Community Center	Permanent relocation	None	Short-term, minor, beneficial
Presence of Construction Vehicles	Duration of onshore facilities construction	None	Short-term, minor, adverse
Conversion of open lots to industrial use	Permanent modification	BMP-51	Long-term, minor, adverse
Operation			
Alteration of the viewshed	Permanent during operation	BMP-51	Long-term, minor, adverse
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on Land Use, Recreational, and Visual Resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.16 Onshore Air Quality

Activities associated with construction and operation of the proposed DOF that would impact onshore air quality include the following:

- Phase I and II construction of proposed DOF, including associated pipelines;
- relocation of Johnson Bayou Community Center; and
- operation of the proposed DOF compressor station.

4.16.1 Impacts of Construction

Construction activities would produce air emissions, predominantly combustion emissions from engines associated with non-road construction equipment and on-road vehicles. Non-road equipment would include compressors, skid loaders, forklifts, track hoes, front-end loaders, cranes, and pile driving hammers. On-road vehicles would include commuter vehicles, gasoline-engine pickup trucks, and diesel-engine passenger buses, flatbed trucks, and delivery trucks. Impacts associated with the proposed Project construction would last for the duration of the construction period (Phase 1: September 2017–October 2018; Phase II: January–October 2020), and would be minor, intermittent, highly localized to construction sites, and adverse. Other construction activities such as welding would generate minor emissions, but these would be minor relative to the combustion emissions. Fugitive particulate matter emissions would also occur from vehicle travel on paved roads, and from soil disturbance at the construction site.

4.16.1.1 Construction Emissions

Table 4.16-1 presents potential emissions from construction of the proposed DOF. Construction emission estimates were based on the duration of operation and engine horsepower rating for each piece of construction equipment. Total days and hours of operation for each source were based on Delfin LNG's project schedule. Emission factors for non-road and on-road sources were generated using USEPA's MOVES2014 model for Cameron County, Louisiana, in CY 2017. Fugitive dust emissions for vehicle traffic on paved roads were estimated using factors from AP-42 Section 13.2.1, and fugitive dust emissions for soil disturbance at the construction site were estimated using factors from AP-42 Section 13.2.3 for total suspended particulate (TSP). PM_{10} emissions were estimated to be 42 percent of TSP, and $PM_{2.5}$ emissions were estimated to be 7.2 percent of TSP, based on ratios provided in AP-42 Section 13.2.4.

Table 4.16-1. Proposed DOF Construction Emissions

Emission Source	Emissions (tons)						
	NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$	VOC	CO_2e
Stage 1 (Sep. 2017 to Oct. 2018)							
Non-Road Equipment Exhaust	5.2	2.0	0.008	0.3	0.3	0.5	1,360
On-Road Vehicle Exhaust	0.3	1.3	0.002	0.01	0.01	0.03	220
Fugitive Dust – Work Site	–	–	–	5.1	0.8	–	–
Fugitive Dust – Off-site Roads	–	–	–	1.8	0.2	–	–
Subtotal	*5.5*	*3.3*	*0.01*	*7.2*	*1.3*	*0.5*	*1,580*
Stage 2 (Jan. 2020 to Oct. 2020)							
Non-Road Equipment Exhaust	3.5	1.4	0.005	0.2	0.2	0.3	920
On-Road Vehicle Exhaust	0.2	0.8	0.001	0.006	0.005	0.02	145
Fugitive Dust – Work Site	–	–	–	3.4	0.1	–	–
Fugitive Dust – Off-site Roads	–	–	–	1.2	0.1	–	–
Subtotal	*3.7*	*2.2*	*0.01*	*4.8*	*0.9*	*0.4*	*1,065*
Totals	**9.2**	**5.5**	**0.02**	**12.0**	**2.1**	**0.9**	**2,645**
Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound							

Construction of the new community center in Johnson Bayou, Louisiana, would result in minor impacts to air quality as a result of heavy equipment used during construction, including bulldozers, cranes, excavators, equipment delivery trucks, and dump trucks. However, this construction represents a relatively small project and would not meet the thresholds requiring issuance of an air emissions permit prior to construction, similar to construction of other residential and/or small commercial projects in the proposed Project area.

4.16.2 Impacts of Operation

Impacts associated with the proposed Project operation would be expected to be long-term, minor and adverse. Emissions generated from the proposed DOF facilities were evaluated based on data provided by Delfin LNG in Resource Report 9 of their FERC licensing application, as amended on November 19, 2015; in Delfin LNG's Title V Air Permit Application submitted to the LDEQ in November 2015; and in subsequent responses to FERC data requests.

Air quality impacts were evaluated based on a dispersion modeling analysis prepared by Delfin LNG in October 2015, and a supplemental cumulative modeling analysis prepared in March 2016. A detailed summary of the air quality impact analysis for criteria pollutants is presented below. Delfin LNG was not required to submit a dispersion modeling analysis as part of its Title V air permit application, because potential emissions from the proposed DOF would be below PSD major source thresholds. However, Delfin LNG conducted its March 2016 analysis in accordance with modeling guideline documents issued by the USEPA and LDEQ. This modeling analysis demonstrates that operating impacts for the proposed DOF would be in compliance with all Federal and State guidelines for acceptable ambient pollutant concentrations.

4.16.2.1 Operation Emissions

Operational emissions from the proposed DOF would be produced by combustion sources at the compressor station, blowdown venting during maintenance and emergency situations, and fugitive leaks from piping components such as pipe flanges, valves, pumps, and compressor seals.

Stationary Source Descriptions

The proposed DOF would include the following stationary emission sources:

- four 30,000 hp Solar Titan 250 gas turbine–driven compressors,
- three 600 kW Waukesha VHP 3604 generators with Waukesha F3524GSI engines,
- four natural gas-fired catalytic fuel gas heaters,
- one natural gas blowdown stack, and
- fugitive emission sources.

Stationary Source Emissions

Table 4.16-2 shows potential annual emissions for operation of the proposed DOF. All sources were assumed to operate for 8,760 hours per year, with the exception of the blowdown stack, which would operate on a very limited basis, estimated to be approximately 4 hours per year.

Table 4.16-2. Proposed DOF Operation Emissions

Emission Source	Emissions (tons per year)						
	NO_x	CO	SO_2	$PM_{10}/PM_{2.5}$	VOC	HAP	CO_2e
4 Titan 250 Gas Turbines	211.3	214.3	13.2	58.0	24.6	3.8	431,084
3 Electrical Generators	12.2	12.2	0.06	1.9	1.2	1.8	13,122
4 Fuel Gas Heaters	0.02	9.0	0.01	–	0.1	–	387
1 Blowdown Stack	–	–	–	–	0.5	0.1	603
Fugitive Emissions	–	–	–	–	0.1	0.01	110
Insignificant Activities	–	–	–	–	0.1	–	–
Totals	**223.5**	**235.5**	**13.2**	**59.9**	**26.5**	**5.7**	**445,305**

Key: CO = carbon monoxide; CO_2e = carbon dioxide equivalent; HAP = hazardous air pollutant; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; SO_2 = sulfur dioxide; VOC = volatile organic compound

4.16.2.2 Operational Air Quality Impacts

An air quality dispersion modeling analysis was performed to demonstrate compliance with NAAQS, and to satisfy the NEPA requirement to assess cumulative impacts. Because the proposed DOF would not be a PSD major source, it was not required to evaluate impacts with respect to Class I areas or PSD Class II increments.

Model Selection

Delfin LNG conducted modeling using the latest version of AERMOD, Version 15181. The analysis was conducted in accordance with the procedures in USEPA's Guideline on Air Quality Models and LDEQ's Air Quality Modeling Procedures.

Operating Scenarios for Modeling

Delfin LNG considered a single operating scenario that included all the proposed combustion sources for the DOF: four Solar Titan 250 compressor turbines, three Waukesha natural gas-fired generator engines, and four natural gas-fired fuel gas heaters. Each of these sources was assumed to operate continuously at its maximum capacity for 8,760 hours per year.

Delfin LNG conducted a modeling analysis in October 2015 that evaluated impacts just from the proposed DOF sources alone, and evaluated compliance with NAAQS standards for NO_2, SO_2, CO, PM_{10}, and $PM_{2.5}$. As requested by FERC, Delfin LNG performed supplemental modeling in March 2016 that evaluated cumulative impacts for 1-hour and annual NO_2, and 1-hour and annual $PM_{2.5}$. Cumulative modeling included emissions from the following specific sources near the proposed DOF:

- Transco Station 44 (located 0.6 km north of the proposed DOF site),
- Stingray Gas Plant (3.1 km to the east),
- Stingray Holly Beach Compressor Station (3.7 km to the east), and
- Cameron Meadows Gas Plant (0.3 km to the north).

Exhaust parameters for these cumulative sources were obtained from LDEQ's Emissions Reporting and Inventory Center website.

Selection of Background Monitoring Data

Ambient background pollutant concentrations were obtained from nearby monitoring sites at Westlake, LA (220190008) for NO_2 and SO_2; Jefferson County, TX (482451035) for CO; Lake Charles, LA (220190010) for $PM_{2.5}$; and Lafayette, LA (220550007) for PM_{10}. Data for the 3-year period of 2012 through 2014 were used.

Receptor Locations

Delfin LNG placed modeling receptors at 50-m intervals along the proposed DOF fenceline, and then in a square grid pattern at intervals of 100 m out to 2,500 m from the fenceline; at intervals of 250 m out to 5,000 m from the fenceline; and at intervals of 1,000 m out to 10,000 m from the fenceline. The AERMAP module of AERMOD was used to place the receptors at elevations representative of the actual terrain, using elevation data obtained from the USGS database of one arc-second National Elevation Data.

Selection of Meteorological Data

Delfin LNG selected both surface and upper air meteorological data from the Lake Charles monitoring site. Data were used for the 5-year period from 2010 through 2014, and were processed through the AERMET and AERSURFACE modules of AERMOD. Hourly average windspeed data were supplemented with archived 1-minute wind measurements to minimize the number of calm and missing hours, for which AERMOD will not evaluate impacts. The AERMINUTE program was used to convert 1-minute wind data into hourly averages.

NO_2 Modeling Approach

Delfin LNG modeled annual NO_2 impacts using USEPA's Tier 2 ARM, assuming a 75 percent NO_x-to-NO_2 conversion ratio in the atmosphere. For modeling 1-hour NO_2 impacts, Delfin LNG used the updated ARM2 proposed by USEPA, which incorporates a variable NO_x-to-NO_2 conversion ratio depending on actual ambient NO_x concentrations. Delfin LNG's cumulative 1-hour NO_2 analysis used a minimum conversion ratio of 0.2 and a maximum ratio of 0.9.

Model Input Parameters

Table 4.16-3 presents the model input parameters used for the proposed DOF emission sources. Table 4.16-4 presents the model input parameters used for nearby cumulative sources.

Table 4.16-3. Model Input Parameters for DOF Point Sources

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	Stack Diam. (ft)	NO_2 (lb/hr)	NO_x (lb/hr)	CO (lb/hr)	$PM_{2.5}$ (lb/hr)	PM_{10} (lb/hr)	SO_2 (lb/hr)	SO_x (lb/hr)
TURB1	Titan 250 Turbine	437843.946	3292582.142	7.6	85	819	83.94	9.03	12.16	12.16	12.34	3.34	3.34	0.76	0.76
TURB2	Titan 250 Turbine	437882.030	3292582.228	7.7	85	819	83.94	9.03	12.16	12.16	12.34	3.34	3.34	0.76	0.76
TURB3	Titan 250 Turbine	437898.600	3292582.142	7.7	85	819	83.94	9.03	12.16	12.16	12.34	3.34	3.34	0.76	0.76
TURB4	Titan 250 Turbine	437936.858	3292582.055	7	85	819	83.94	9.03	12.16	12.16	12.34	3.34	3.34	0.76	0.76
GEN1	Electrical Generator	437880.815	3292555.814	6.9	65	1,142	9.86	3	0.93	0.93	0.93	0.14	0.14	3.97E-03	3.97E-03
GEN2	Electrical Generator	437886.801	3292554.901	6.9	65	1,142	9.86	3	0.93	0.93	0.93	0.14	0.14	3.97E-03	3.97E-03
GEN3	Electrical Generator	437893.047	3292554.814	6.8	65	1,142	9.86	3	0.93	0.93	0.93	0.14	0.14	3.97E-03	3.97E-03
HTR1	Fuel Gas Heater3	437835.810	3292588.350	7.5	33	60	0.003	0.67	8.90E-04	8.90E-04	0.51	0	0	7.30E-04	7.30E-04
HTR2	Fuel Gas Heater3	437835.810	3292579.030	7.7	33	60	0.003	0.67	8.90E-04	8.90E-04	0.51	0	0	7.30E-04	7.30E-04
HTR3	Fuel Gas Heater3	437941.150	3292588.350	6.9	33	60	0.003	0.67	8.90E-04	8.90E-04	0.51	0	0	7.30E-04	7.30E-04
HTR4	Fuel Gas Heater3	437941.150	3292579.030	7.2	33	60	0.003	0.67	8.90E-04	8.90E-04	0.51	0	0	7.30E-04	7.30E-04

Key:
CO = carbon monoxide; CO_2e = carbon dioxide equivalent; F = Fahrenheit; ft = feet; lb/hr = pound per hour; ft/s = feet per second; m = meter; NO_x = nitrogen oxides; PM_{10} = particulate matter with an aerodynamic diameter less than or equal to 10 microns; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns; SO_2 = sulfur dioxide; SO_x = sulfur oxides; VOC = volatile organic compound

Table 4.16-4. Model Input Parameters for Onshore Nearby Sources

Source ID	Source Description	Easting (X) (m)	Northing (Y) (m)	Base Elev. (ft)	Stack Ht. (ft)	Temp (F)	Exit Velocity (ft/s)	Stack Diam. (ft)	NO_2 (lb/hr)	NO_x (lb/hr)	$PM_{2.5}$ (lb/hr)
Offste1	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437768.033	3293237.415	4.40	48.0	950.0	9.1	1.50	0.21	0.21	0.02
Offste2	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	52.0	850.0	7.0	2.00	0.21	0.21	0.00
Offste3	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	29.3	1045.0	85.8	0.34	2.56	2.56	0.02
Offste4	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	29.3	1045.0	85.8	0.34	3.08	3.08	0.03
Offste5	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437864.787	3293257.681	3.74	39.7	875.0	46.8	1.10	3.23	3.23	0.11
Offste6	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	6.0	1370.0	113.0	0.26	4.50	4.50	0.04
Offste7	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	80.0	1832.0	65.6	3.30	13.87	13.87	0.00
Offste8	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437698.145	3293253.014	4.49	10.0	1095.0	37.4	1.20	15.36	15.36	0.04
Offste9	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	45.4	838.0	132.4	3.34	17.09	17.09	0.00
Offste10	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	45.4	838.0	132.4	3.34	17.09	17.09	0.00
Offste11	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	45.4	838.0	132.4	3.34	26.95	26.95	0.31
Offste12	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437720.918	3293177.614	4.27	33.0	864.0	64.3	7.55	30.11	30.11	2.33
Offste13	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437734.402	3293205.537	4.72	33.0	864.0	64.3	7.55	30.11	30.11	2.33
Offste14	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	52.0	850.0	7.0	2.00	0.00	0.00	0.02
Offste15	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	45.4	838.0	132.4	3.34	0.00	0.00	0.31
Offste16	Transcontinental Gas Pipe Line Co LLC - Transco Compressor Station	437831.570	3293175.090	4.43	45.4	838.0	132.4	3.34	0.00	0.00	0.31
Offste19	Stingray Onshore Separation Facility	441073.378	3292579.702	7.05	14.8	450.0	208.0	0.75	1.27	1.27	0.00
Offste20	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438295.072	3292645.248	5.94	150.0	1832.0	65.6	3.00	0.17	0.17	0.02
Offste21	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438233.225	3292733.731	5.05	28.0	1463.0	611.5	0.33	0.56	0.56	0.03
Offste22	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438201.283	3292584.628	6.82	20.0	500.0	13.1	2.00	0.77	0.77	0.07
Offste23	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438201.283	3292584.628	6.82	20.0	500.0	13.1	2.00	0.77	0.77	0.07
Offste24	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438252.033	3292681.839	4.76	10.0	920.0	192.0	0.33	3.97	3.97	0.28
Offste25	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438249.422	3292631.823	6.10	36.1	869.0	137.0	3.34	12.80	12.80	0.26
Offste26	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438257.422	3292631.494	6.10	36.1	869.0	137.0	3.34	12.80	12.80	0.26
Offste27	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438263.363	3292631.295	6.10	36.1	869.0	137.0	3.34	12.80	12.80	0.26
Offste28	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438271.127	3292631.209	6.07	36.1	869.0	137.0	3.34	12.80	12.80	0.26
Offste29	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438236.099	3292726.274	5.05	40.0	950.0	52.6	0.85	18.46	18.46	0.16
Offste30	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438246.734	3292726.215	5.15	40.0	950.0	52.6	0.85	18.46	18.46	0.16
Offste31	PSI Midstream Partners LP - Cameron Meadows Gas Plant	438147.161	3292727.874	5.61	33.5	987.0	48.4	11.31	102.19	102.19	1.50
Offste32	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	165.0	300.0	0.4	3.00	0.11	0.11	0.01
Offste33	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	25.5	900.0	49.3	1.00	0.36	0.36	0.03
Offste34	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	34.5	1543.0	89.0	2.00	0.58	0.58	0.04
Offste35	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	10.0	700.0	118.0	0.17	3.38	3.38	0.01
Offste36	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	20.0	850.0	151.9	0.70	41.68	41.68	0.10
Offste37	Targa Midstream Services LLC - Stingray Gas Plant	441073.378	3292579.702	7.05	30.0	680.0	123.0	1.67	117.58	117.58	0.66
Offste38	Stingray Pipeline Co - Holly Beach Compressor Station	441593.668	3292674.063	3.44	24.0	420.0	32.7	1.00	0.15	0.15	0.00
Offste39	Stingray Pipeline Co - Holly Beach Compressor Station	441593.668	3292674.063	3.44	30.3	270.0	14.1	1.50	0.17	0.17	0.00
Offste40	Stingray Pipeline Co - Holly Beach Compressor Station	441593.668	3292674.063	3.44	34.6	270.0	20.1	1.50	0.25	0.25	0.00
Offste41	Stingray Pipeline Co - Holly Beach Compressor Station	441593.668	3292674.063	3.44	40.0	835.0	73.0	27.75	3.70	3.70	0.00
Offste42	Stingray Pipeline Co - Holly Beach Compressor Station	441456.399	3292622.480	5.05	40.0	835.0	21.0	4.00	15.87	15.87	0.00

Key: F = Fahrenheit; ft = feet; m = meter; NO_2 = nitrogen dioxide; NO_x = nitrogen oxides; $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 2.5 microns;

Summary of Results

Table 4.16-5 compares modeled impacts plus existing background concentrations against the NAAQS. For CO, PM_{10}, and SO_2, only emissions from the proposed DOF sources were included. For NO_2 and $PM_{2.5}$, the modeled impacts include the contributions from the nearby offsite sources identified in Table 4.16-4.

Predicted impacts showed compliance with the NAAQS for all pollutants and averaging periods except for 1-hour NO_2, which showed an exceedance of the NAAQS. Delfin LNG performed a culpability analysis to determine the maximum contribution of the proposed DOF modeled emissions to the total cumulative modeled emissions at receptors indicating an exceedance of the 1-hour NO_2 NAAQS. It was found that the maximum contribution of the proposed DOF at these receptors would be 4.1 $\mu g/m^3$, which is less than the interim PSD SIL of 7.5 $\mu g/m^3$. These modeling results indicate that emissions from the proposed DOF would contribute a very minor fraction of the total concentrations at receptors indicating an exceedance of the 1-hour NO_2 NAAQS, and the exceedance at these receptors is pre-existing and predominantly attributable to emissions from nearby sources.

Table 4.16-5. Proposed DOF and Cumulative Modeling Results vs. NAAQS

Pollutant	Averaging Period	Maximum Modeled Concentration ($\mu g/m^3$)	Background ($\mu g/m^3$)	Total Impact (Modeled + Background) ($\mu g/m^3$)	NAAQS ($\mu g/m^3$)	Percent of Standard
CO (DOF only)	8-hour	300.33	685.80	986.13	10,000	10%
	1-hour	1,035.64	845.82	1,881.46	40,000	5%
NO_2 (cumulative)	Annual	53.21	9.82	63.0	100	63%
	1-hour	238.62	54.81	293.4	188	156%
PM_{10} (DOF only)	24-hour	7.02	77.00	84.02	150	56%
$PM_{2.5}$ (cumulative)	Annual	1.11	7.90	9.0	12	75%
	24-hour	5.54	17.77	23.3	35	67%
SO_2 (DOF only)	3-hour	0.67	96.94	97.62	1,300	8%
	1-hour	1.15	92.33	93.48	196	48%

Key: CO = carbon monoxide; NAAQS = National Ambient Air Quality Standards; NO_2 = nitrogen dioxide; PM_{10} / $PM_{2.5}$ = particulate matter with an aerodynamic diameter less than or equal to 10 / 2.5 microns; SO_2 = sulfur dioxide; $\mu g/m^3$ = microgram per cubic meter

4.16.3 Impacts of Decommissioning

Proposed Project decommissioning would result in comparable emissions to those described for the construction process. Impacts associated with proposed Project decommissioning would be expected to last for the duration of the decommissioning period, and be minor, intermittent, highly localized to the sites for decommissioning activities, and adverse.

4.16.4 General Conformity

Under Section 176(c)(1) of the CAA, a General Conformity applicability evaluation is required for Federal actions that would result in emissions of criteria pollutants in an area designated as a nonattainment or maintenance area with respect to the NAAQS. If such emissions exceed certain thresholds, a more thorough General Conformity determination is required in order to demonstrate that the activity would comply with all applicable SIPs.

No emissions from construction or operation of the Project would occur in any designated nonattainment or maintenance area. Therefore, no further evaluation of potential Project emissions with respect to General Conformity is required.

4.16.5 Greenhouse Gases and Climate Change

Equipment used during construction, operation, and decommissioning of the proposed DOF would produce emissions of GHGs, primarily CO_2 and to a lesser extent CH_4 and N_2O. Fugitive CH_4 emissions may also occur from fugitive losses of natural gas from valves, flanges, and other components of the compressor station, meter station, and supply header. Potential GHG emissions from construction, operation, and decommissioning of the DOF have been estimated in accordance with CEQ's final guidance regarding the evaluation of GHG emissions and climate change impacts (CEQ 2016; see Section 4.9.5).

4.16.5.1 Construction

For non-road and on-road equipment used during construction, GHG emission factors for non-road and on-road sources were generated using USEPA's MOVES2014 model for Cameron County, Louisiana in calendar year 2017. Total emissions were estimated based on the duration of operation and engine horsepower rating for each piece of construction equipment. Total days and hours of operation for each source were based on Delfin LNG's project schedule.

GHG emissions during the construction period are provided in Table 4.16-1. Total GHG emissions from construction of Phases I and II, expressed as CO_2e emissions, would be 2,645 tons.

4.16.5.2 Operation

GHG emissions from operation of the proposed DOF are provided in Table 4.16-2. As shown, total operational GHG emissions, expressed as CO_2e, would be 445,305 tons per year after the completion of Phases I and II.

4.16.5.3 Decommissioning

GHG emissions from decommissioning would be similar to those from construction. Proposed decommissioning actions would burn fossil fuel in various types of engines and equipment and produce CO_2 and N_2O from the fossil fuel combustion.

4.16.5.4 Effects of Future Climate Change on Project Impacts

The USGCRP's 2014 National Climate Assessment makes the following projections for potential climate change in the southeast region of the United States, which could affect the vicinity of the proposed DOF during its expected lifetime:

- The combination of projected sea level rise with local subsidence of coastal land poses a significant risk of damage to infrastructure as coastal areas become increasingly flood-prone.
- Saltwater intrusion is projected to reduce the availability of fresh water from rivers, streams, and groundwater sources.
- The frequency, intensity, and duration of heat waves is expected to increase. The average number of days exceeding 95°F currently ranges between 0-10 days per year in the vicinity of the proposed DOF, and could increase to between 30-45 days per year during the 2041-2070 time period.
- Changes in precipitation patterns are expected. During the expected Project lifetime, the National Climate Assessment projects overall drier conditions in southwest Louisiana compared to the historical climate. Despite this overall decrease in precipitation, the frequency of extreme precipitation events is expected to increase.
- Tropical storms and hurricanes are expected to become less frequent overall, but the frequency of intense hurricanes (category 4 or 5) is expected to increase.
- Heat stress due to warmer summers is projected to reduce livestock yields and crop productivity.

- Increased demand for summer air conditioning may put stress on electric generation and distribution infrastructure.
- Climate impacts on southeastern forests may be mixed, with some insects and pathogens becoming more prevalent, while other decrease as a result of higher temperatures.
- Climate impacts on human exposure to vector-borne diseases may also be mixed, as some conditions (temperature) may become more favorable for disease transmission, while others (vegetation and humidity) become less favorable.

These projected climate change effects in the vicinity of the proposed DOF are not anticipated to exacerbate any other environmental impacts from the proposed Project during its expected lifetime. However, the proposed DOF would need to be designed and operated to safely account for the potential effects of sea level rise and flooding events.

4.16.6 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.16.6.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore air quality.

4.16.6.2 Alternative DOF Location

Delfin LNG considered four locations for the proposed DOF that met the Project's required criteria, including proximity to the gas supply pipeline for the offshore deepwater Port, proximity to gas supply header pipelines of sufficient capacity, and selection of a site on previously developed land rather than a greenfield site.

Total emissions from construction, operation, and decommissioning would be essentially identical at any of the alternative sites. Modeled air quality impacts would differ slightly depending on which alternative site was chosen for the compressor station, but there would be no qualitative difference with respect to compliance with air quality standards.

4.16.6.3 Alternative Compressor Station Design

Two alternatives were considered for removal of natural gas from the compressor station and gas handling components during maintenance and emergency situations. During such events, natural gas can either be vented directly to the atmosphere through a blowdown stack, or it can be burned in a flare. Unburned natural gas consists mostly of CH_4 with trace amounts of CO_2 present. This CH_4 would be converted to CO_2 when burned. The blowdown stack, which was selected as the Applicant's proposed alternative, would result in greater GHG emissions on a CO_2e basis compared to use of a flare, due to the greater global warming potential of CH4 compared to CO_2. However, the estimated blowdown emissions for the proposed DOF are very small, emitting 24.1 tons per year (tpy) of CH_4 and 0.5 tpy of CO_2, resulting in GHG emissions of 603 tpy on a CO_2e basis. Although burning these venting emissions in a flare would result in lower GHG emissions of 109 tpy on a CO_2e basis, the GHG emissions from the blowdown stack alternative would only represent 0.13 percent of the potential GHG emissions for the entire DOF.

4.16.7 Best Management Practices

Delfin LNG has committed to the following BMP:

- **BMP-67:** All Project-related activities will comply with Federal, State, and local regulations to control air emissions generated by construction and operation of the proposed DOF.

4.16.8 Recommendations and Conclusions

Impacts on onshore air quality would be adequately mitigated by the Applicant through design modifications and implementation of mitigation measures recommended by Federal and State agencies; therefore, the USCG does not recommend additional mitigation measures to be implemented.

Based on implementation of the BMPs identified in Section 4.16.7 and the recommendations listed above, we have determined impacts would be as described in Table 4.16-6.

Table 4.16-6. Summary of Impacts for Onshore Air Quality

Aspects of Proposed Action With Potential to Affect Resource	Amount/Frequency	Applicable Best Management Practices	Severity of Effect
Construction			
Phase I construction of proposed DOF, including associated pipelines	Sept. 2017- Oct. 2018	BMP-67	Short-term, minor, adverse
Phase II construction of proposed DOF, including associated pipelines	Jan.-Oct. 2020	BMP-67	Short-term, minor, adverse
Operation			
Operation of the proposed DOF compressor station	Continuous throughout operation	BMP-67	Long-term, minor, adverse
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on onshore air quality would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.17 Onshore Noise

The potential noise impacts and mitigation measures with respect to noise, as discussed in Section 3.17, associated with construction, operation, maintenance and decommissioning for the proposed onshore facilities are discussed in the following subsections. The proposed DOF would consist of a meter station, a gas supply header, and a compressor station, located in Cameron Parish, Louisiana. The section includes useful metrics, common sources, as well as the regulatory environment at the local, State, and Federal level for the proposed DOF.

Activities associated with construction and operation of the proposed Project that would impact onshore noise include the following:

- construction of proposed DOF, including associated pipelines;
- relocation of Johnson Bayou Community Center; and
- continuous noise produced by proposed DOF equipment, including compressors, generators, and cooling fans.

4.17.1 Impacts of Construction

Construction activities at the proposed DOF site would involve clearing and grading; placing fill; installing foundations for the planned DOF, other equipment settings, ancillary equipment, piping, and structures; and pile driving. Construction of the proposed DOF would cause temporary increases in ambient noise levels in the immediate vicinity of the construction sites. Construction operating hours would be from 7:00 a.m. to 7:00 p.m., Monday through Saturday.

Noise levels resulting from construction equipment depend on several factors, including the number and type of equipment operating, the level of operation, and the distance between sources and receptors. The loudest equipment during construction would contribute to a composite average or equivalent site noise level. Heavy construction equipment typically generates noise levels up to approximately 95 dBA at 50 ft. As part of this analysis, acoustic noise modeling was conducted to estimate the construction noise levels at the nearest NSAs around the proposed DOF site. Tables 4.17-1 and 4.17-2 present the expected proposed DOF construction equipment types and quantities for site preparation and facility construction that were used in the noise calculations and the estimated noise levels at various distances. Noise emission levels were gathered from equipment manufacturers and government agency references. The usage factors were selected from the Federal Highway Administration Highway Construction Noise Handbook (U.S. Department of Transportation 2006). Usage factors are used to account for the intermittent use of construction equipment throughout the course of a normal workday.

The nearest NSAs (e.g., residences, churches, schools) were identified. The community center would be moved, and the building on-site would be repurposed as an office space. Therefore, the nearest NSA (5870 Gulf Beach Highway) to the proposed DOF is approximately 3,380 ft from the approximate center of the construction site where a compressor station would be installed. The estimated noise level from DOF construction at that distance would be 53 dBA during site preparation and 58 dBA during facility construction. These levels might occur temporarily over the course of construction and may be audible at the nearest NSAs. Figure 4.17-1 shows the distance from the DOF construction to each NSA. While construction could produce noise levels that may be perceptible at the nearby NSAs, the noise increment would be temporary and limited to daytime hours.

Table 4.17-1. Site Preparation Construction Noise Levels at Various Distances

Construction Equipment	Quantity	Usage Factor (%)	L_{max} SPL @ 50 Feet (dBA)	Sound Level (dBA) at Distance (feet)				
				50	250	500	1,000	1,500
Pickup Truck	3	40	75	76	62	56	50	46
Flatbed Truck	1	40	74	70	56	50	44	40
Dump Truck	8	40	76	81	67	61	55	52
Fuel Truck	1	40	76	72	58	52	46	42
Dozer	6	40	82	86	72	66	60	56
Backhoe	2	40	78	77	63	57	51	47
Trackhoe	3	40	78	79	65	59	53	49
Grader	2	40	85	84	70	64	58	54
Sheepsfoot Roller	4	20	80	79	65	59	53	49
Drum Roller	4	20	80	79	65	59	53	49
Composite Noise Level				90	76	70	64	61

Key:
dBA = A-weighted decibels; L_{max} = maximum sound level; SPL = sound pressure level
Source: U.S. Department of Transportation (2006)

Table 4.17-2. Facility Construction Noise Levels at Various Distances

Construction Equipment	Quantity	Usage Factor %	L_{max} SPL @ 50 Feet (dBA)	Sound Level (dBA) at Distance (feet)				
				50	250	500	1,000	1,500
Pickup Truck	2	40	75	74	60	54	48	43
Flatbed Truck	2	40	74	73	59	53	47	43
Concrete Truck	2	40	79	78	64	58	52	48
Concrete Pump Truck	2	20	81	77	63	57	51	47
Fork Truck	2	40	84	83	69	63	57	53
Manlift	2	20	75	71	57	51	45	41
Backhoe	2	40	78	77	63	57	51	47
Trackhoe	2	40	78	77	63	57	51	47
Picker	6	16	81	81	67	61	55	51
Crane	1	16	81	73	59	53	47	43
Welder	4	40	74	76	62	56	50	46
Compressor	2	40	78	77	63	57	51	47
Compactor	2	20	83	79	65	59	53	49
Pile Driver	1	20	101	94	80	74	68	64
Composite Noise Level				95	81	75	69	66

Key:
dBA = A-weighted decibels; L_{max} = maximum sound level; SPL = sound pressure level
Source: U.S. Department of Transportation (2006)

Construction of the new community center in Johnson Bayou, Louisiana, would result in minor impacts to noise as a result of heavy equipment used during construction. Noise levels will meet local Cameron Parish requirements and would not result in a nuisance to the local population, similar to construction of a residential and/or small commercial project.

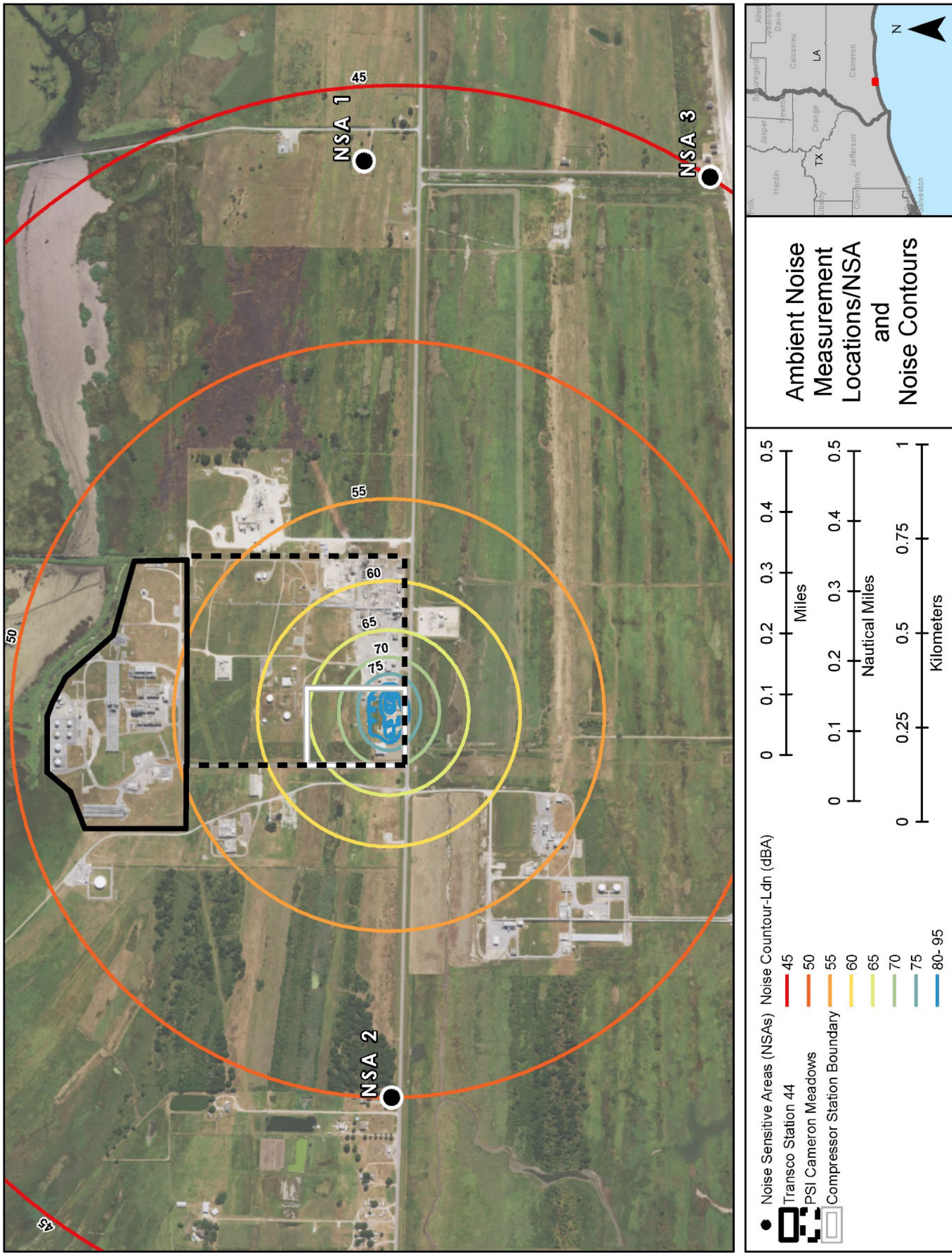


Figure 4.17-1. **Ambient Noise Measurement Locations/NSA and Noise Contours**

4.17.2 Impacts of Operation

Operation of the proposed DOF may result in long-term increases in noise levels in the vicinity of the proposed DOF site. Noise would generally be produced on a continuous basis by the proposed DOF equipment, including compressors, generators, and lube oil coolers.

To identify potential noise impacts resulting from the operation of the proposed DOF, acoustic modeling was conducted and the modeling results were compared with the FERC limit of L_{dn} 55 dBA. Acoustic noise modeling of the major DOF sources was conducted using the Computer-Aided Noise Abatement (known as "CadnaA") acoustic model version 3.7.124 developed by Datakustik GmbH.

Information about the primary noise-producing equipment at the proposed DOF, along with corresponding estimated noise-emission data and noise-control equipment-reduction values, was derived from equipment manufacturer's data sheets. The model simulates the outdoor three-dimensional propagation of sound from each noise source and accounts for sound wave divergence, atmospheric and ground sound absorption, and sound attenuation due to interceding barriers and topography based on the International Standard ISO9613-2 (ISO 1996). Standard conditions of 50°F and 70 percent relative humidity were assumed. Ground absorption was set to 0.5. A database was developed that specified the location and sound power levels of each noise source. A receptor grid was specified that covered the entire area of interest. The model calculated the overall A-weighted SPLs within the receptor grid based on the sound level contribution of each noise source. The model receptors included the three nearest identified NSAs.

Table 4.17-3 presents the unmitigated sound levels for the major noise-producing equipment associated with the proposed DOF.

Table 4.17-3. Unmitigated Sound Levels for Major Noise-Producing Equipment

Name	Quantity	Octave Band Frequencies Unweighted Sound Levels (dBL)								
		31.5	63	125	250	500	1,000	2,000	4,000	8,000
Inlet (unsilenced) Titan 250	4	110.0	115.0	128.0	129.0	130.0	132.0	135.0	174.0	166.0
Exhaust (unsilenced) Titan 250	4	124.0	128.0	126.0	128.0	132.0	127.0	119.0	109.0	100.0
Compressor (enclosed) Titan 250	4	121.2	114.2	111.2	108.2	106.2	105.2	103.2	100.2	95.2
Lube oil coolers (low noise)	4	97	104.5	101.5	94.5	89.5	86.5	82.5	78.5	73.5
600 kW Waukesha generators with enclosure and muffler	3	–	–	–	–	111	–	–	–	–

Key:
dBL = linear decibel

Table 4.17-4 presents the noise reduction values for the potential noise controls that were included in the model. Turbine exhaust silencers will be specified with a sound specification of 55 dBA at 300 ft. This will serve to further reduce the noise contribution at the NSAs. The specification for the compressor station building ventilation system will include noise criteria of 85 dBA at 3 ft from the building for all penetrations.

Table 4.17-4. Noise Mitigation Summary

Noise Source	Noise Control	Octave Band Frequencies Unweighted Sound Levels (dBL)								
		31.5	63	125	250	500	1000	2000	4000	8000
Gas Turbine Inlet	Inlet Silencer	3.0	7.0	13.0	23.0	40.0	54.0	57.0	59.0	48.0
Gas Turbine Exhaust	Exhaust Silencer	2.0	8.0	12.0	22.0	39.0	42.0	44.0	32.0	24.0
Compressors	Building	6	12	18	25	30	32	35	38	40

Key:
dBL = linear decibel

Once the facility is operational, noise measurement will be conducted (within a year after the compressor station starts operations) at the NSAs while the facility is operating under full load conditions. Additionally, Delfin LNG confirms that it will file the results of the noise survey with the Secretary of the Commission no more than 60 days after placing each of the two construction phases of the Delfin compressor station into service. For the noise survey following each of the two construction phases the following will apply: If a full load condition noise survey is not possible, Delfin LNG confirms that it will provide an interim survey at the maximum possible horsepower load and provide the full load survey within 6 months. If the noise attributable to the operation of all of the equipment at the Delfin compressor station under interim or full horsepower load conditions exceeds day-night sound level of 55 dBA at any nearby NSA, Delfin LNG confirms that it will file a report with the Secretary of the Commission (Secretary) on what changes are needed and will install the additional noise controls to meet the level within 1 year of the in-service date. Recommendation FERC-13 found in Appendix G also requires Delfin LNG to confirm compliance by filing a second noise survey with the Secretary no later than 60 days after it installs any necessary additional noise controls.

The results indicate that sound levels at the nearest NSA that would be associated with the operation of the proposed DOF would be L_{dn} 50.6 dBA, which is below the FERC limit of L_{dn} 55 dBA. Table 4.17-5 presents the expected increase in L_{dn} above the existing L_{dn}. The expected increases in noise levels at the NSAs range from 0.1 dBA to 1.0 dBA. Figure 4.17-1 shows the modeled operational noise impacts at the NSAs.

Table 4.17-5. Compressor Station Operational Noise Impacts at NSAs

NSA	Distance from NSA (feet)	Direction from NSA to Site Center	Existing Ambient Ldn (dBA)	DOF Contribution Ldn (dBA)	Combined Ldn (dBA)	Expected Increase
#1	4,765	West	52.2	46.4	53.2	1.0
#2	3,380	East	65.3	50.6	65.4	0.1
#3	5,460	Northwest	55.8	45.3	56.2	0.4

Key:
dBA = A-weighted decibels; L_{dn} = day-night sound level; DOF = Delfin Onshore Facility

Maintenance and repair could result in noise impacts that are likely minor and short-term.

4.17.3 Impacts of Decommissioning

Noise effects from decommissioning are likely similar to those as during construction, and are expected to be minor and short-term. It is expected the proposed DOF would be in operation for at least 30 years. Potential noise impacts would be reassessed prior to decommissioning based on environmental conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7(b) of the Natural Gas Act when Delfin LNG submits an application to abandon the natural gas pipeline and ancillary facilities.

4.17.4 Impacts of Alternatives

In addition to the proposed DOF, alternative DOF locations and compressor station designs were evaluated. Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco's Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). A No Action Alternative was also evaluated.

4.17.4.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on onshore noise.

4.17.4.2 Alternative DOF Location

Changes to expected airborne noise impacts could occur based on the site-specific factors, such as geography and distance to NSAs. Four locations were considered for the proposed DOF. Due to the proximity of the alternative locations, the noise sources would maintain setback distances to the nearest receptors with a standard facility layout, and the alternative locations are expected to have similar noise impacts as the proposed DOF.

4.17.4.3 Alternative Compressor Station Design

Changes to expected airborne noise impacts could occur based on the compressor station design and the technologies selected. Electric turbines may serve as an alternative compressor station design candidate. However, it is likely that alternative compressor stations would have similar noise impacts on the environment.

4.17.5 Best Management Practices

Delfin LNG has committed to the following BMPs:

- **BMP-68:** Delfin LNG will implement the following measures to minimize impacts on noise receptors during construction:
  - Perform construction during daytime hours when there is less sensitivity to sound;
  - Locate stationary construction equipment away from noise receptors where feasible;
  - Turn off idling equipment when not in use; and,
  - Install temporary acoustic barriers around stationary construction noise sources, as feasible.
- **BMP-69:** The Project requires mitigation of noise emissions from many different sources in order to meet its commitments regarding noise levels at NSAs. Two primary noise sources are the turbine air inlets and exhausts, with key elements of the noise mitigation strategy including the use of silencers. Low-noise lube oil coolers will be installed. In addition, the following key equipment components have been specified with acoustical building enclosures:
  - gas turbines,
  - gas compressors, and
  - Waukesha generator.

  Building enclosures are normally steel sandwich construction: a steel skin, mineral wool within the wall section and a perforated metal interior wall for sound absorption. At a minimum, walls/roof of the building should be constructed with exterior steel of 22 gauge and an interior layer of 4-inch-thick unfaced fiberglass covered with 26-gauge steel perforated liner. The specification for the compressor building and generator buildings will include noise criteria of 85 dBA at 3 ft from the building for all penetrations.

4.17.6 Recommendations and Conclusions

After review of Delfin LNG's DWPA Application and Section 7(c) Application, FERC has determined that the following additional recommendation should be implemented in addition to the previously mentioned BMPs to minimize impacts from onshore noise.

- **FERC Rec-13:** Delfin LNG shall file a noise survey with the Secretary **no later than 60 days** after placing the DOF Compressor Station in service. If a full load condition noise survey is not possible, Delfin LNG shall provide an interim survey at the maximum possible horsepower load and provide the full load survey **within 6 months**. If the noise attributable to the operation of all of the equipment at the DOF Compressor Station under interim or full horsepower load conditions exceeds an L_{dn} of 55 dBA at any nearby NSAs (or noise-sensitive areas), Delfin LNG shall file a report on what changes are needed and shall install the additional noise controls to meet the level **within 1 year** of the in-service date. Delfin LNG shall confirm compliance with the above requirement by filing a second noise survey with the Secretary **no later than 60 days** after it installs the additional noise controls.

Based on implementation of the BMPs and measures identified above, we have determined impacts would be as described in Table 4.17-6.

Table 4.17-6. Summary of Impacts for Noise

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Construction noise associated with proposed DOF	Intermittent impacts during the two construction periods (13 months, 10 months)	BMP-68	Moderate, short-term, adverse
Operation			
Continuous noise associated with DOF, including compressors, generators, and cooling fans	Intermittent impacts throughout operation	BMP-69 FERC Rec-13	Negligible
Decommissioning			
It is expected the proposed DOF would be in operation for at least 30 years. Potential impacts on the on-shore acoustic environment would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.18 Socioeconomics

This section addresses potential impacts on socioeconomics associated with the proposed Project and alternatives. The socioeconomic resources potentially affected by the proposed Project are discussed in Section 3.18. Because all socioeconomic resources, even those associated with offshore industries such as fishing and marine commerce, are tied to onshore inhabitants and conditions, the discussion of impacts on socioeconomic resources has been combined into one section, rather than dividing it between onshore and offshore impacts as is done for other resources in Section 4.0. Socioeconomic resources discussed in this section include both onshore and offshore economic conditions such as population and demographics, housing, employment and income, land- and marine-based tourism and recreation, commercial and recreational fisheries, marine commerce and shipping, other offshore resources, and public services.

Activities associated with construction and operation of the proposed Project that would impact socioeconomics include the following:

- employment and associated relocation of temporary and/or permanent workers,
- payment of wages and taxes,
- relocation of Johnson Bayou Community Center,
- use of public services,
- restricted marine access, and
- disturbance of seafloor and associated fish habitat.

Construction of the proposed Project would result in short-term, adverse, and reversible impacts on offshore industries such as commercial fishing and marine commerce; however, impacts due to job creation would be short-term, moderate, and beneficial. Operation of the proposed Project would result in negligible, long-term, adverse impacts on commercial fishing and other marine-focused economies; however, job creation during construction and operation would result in long-term and short-term, major, and beneficial impacts. Decommissioning of the proposed Project would produce similar disturbance impacts as previously described for construction activities, with adverse impacts on certain offshore industries and beneficial impacts due to job creation. Overall, impacts on onshore socioeconomic resources such as population and demographics, housing, and public services would be negligible.

A summary of the proposed Project's attributes that most directly influence the proposed Project's potential impacts on socioeconomic conditions in the region is provided in Tables 4.18-1 and 4.18-2.

Table 4.18-1. Proposed Port Delfin LNG Project: Workforce Summary Sheet – Construction

Project Component Schedule	Duration (months)	Average Monthly Workforce	Peak Workforce	Worker Origin a/	Work Cycle	Average Annual Salary	Total Payroll
Offshore Construction Workforce for pipeline installation 2018 - Pipeline Installation Work	7.5	77	165	90% regional/ 10% non-local	14 days on/ 14 days off	$75,000	$8.9 million
Offshore Construction Workforce per TYMS Installation/Hook-up/Commissioning and Subsea Riser Installation and Dewatering 2018 – TYMS #1 2019 – TYMS #2 2020 – TYMS #3 2021 – TYMS #4	3.5	79	138	90% regional/ 10% non-local	14 days on/ 14 days off	$75,000	$4.7 million
Offshore Construction Workforce per FLNGV Installation/Hook-up/Commissioning 2019 – FLNGV #1 2020 – FLNGV #2 2021 – FLNGV #3 2022 – FLNGV #4	4.5	46	53	90% regional/ 10% non-local	14 days on/ 14 days off	$98,280	$5.1 million
DOF Construction Workforce 13-month construction stage (Oct 2017–Nov 2018) 10-month construction stage (Jan – Oct 2020)	23	70	170	65% local/ 35% non-local	10-hour shifts, up to 6 days/week	$87,000	$10.0 million
Note: a/ Regional – Mostly Louisiana and Texas. Non-Local – Outside of Louisiana and Texas.							

Table 4.18-2. Proposed Port Delfin LNG Project: Workforce Summary Sheet – Operation

Project Component	Total	Worker Origin a/	Work Cycle	Average Annual Salary	Annual Payroll
FLNGV	416 (103 per vessel)	70% United States / 30% international	21 days on/21 days off	$103,000	$43 million/year
Shore-based Team	64	20% regional/ 80% non-local	Full time	$129,000	$8.3 million/year
DOF Workforce	9	50% local/ 50% non-local	Full time	$85,000	$1 million
Note: a/ Regional – Mostly Louisiana and Texas. Non-Local – Outside of Louisiana and Texas.					

4.18.1 Onshore Economic Conditions

Potential impacts on onshore economic conditions during construction, operation, and decommissioning of the proposed DOF would result from purchase of goods and services, increased employment, and generation of income, which would produce moderate, beneficial impacts in the proposed Project area and surrounding region.

4.18.1.1 Impacts of Construction

A land-based staging area for activities associated with offshore pipeline and TYMS installation would be selected during the preconstruction phase. The prefabricated pipeline components would be delivered and stored at and existing staging area until a qualified installation contractor is ready for installation offshore. If the contractor is hired earlier in the process, the contractor's base of operations may, in part, determine the most efficient base. Assembly of the TYMS and FLNGVs would likely occur outside of the proposed Project area, and individually, the TYMS would be loaded on barges and transported to the proposed Port location offshore. The FLNGVs would navigate independently to the proposed Port site, according to the proposed Project schedule. The proposed staging area would most likely be an existing laydown area located within a regional area port. Because the TYMS and FLNGVs would move over water directly to the installation site, staging activities are expected to be minor. Also, pipeline components for the proposed pipeline bypass, approximately 700 ft long, would arrive prefabricated and would not require extensive storage area.

There would be no need for any new or expanded construction, laydown or parking areas to construct the proposed Project. Delfin LNG would use existing Gulf of Mexico fabrication and pipeline yards. The U.S.-based construction associated with the proposed Project would be limited in scope and could be accommodated within the existing permitted footprints of several existing offshore fabrication and pipeline facilities.

Population and Demographics

During subsea pipeline installation (for both the bypass and laterals), the Applicant anticipates employing a workforce of 77 workers per month (average) for 7.5 months until the work is complete. The largest number of workers employed at one time (peak workforce) would be approximately 165. This small number of workers would not impact the populations in the impact area if they were to move to the towns and cities near the proposed Project. The average period of employment for each worker is estimated to be 80 days.

The Applicant anticipates installing the first TYMS (TYMS #1) over a 3.5-month period, followed by installation of the first FLNGV (FLNGV #1) over a 4.5-month period. The schedule includes a 2-month break between the TYMS and FLNGV installation during the winter months, so the work would not be continuous for 8 months. TYMS #2 and FLNGV#2 would be installed according to the same schedule one year later, followed by the remaining pairs of TYMS and FLNGVs installed in each consecutive year. At full build out, the proposed Project would consist of four TYMSs and four FLNGVs. Installation and commissioning of the first TYMS (TYMS #1) could overlap by about a month or so with pipeline installation activities, a negligible amount in terms of workers' presence in the impact area and their impact on the population. After pipeline installation is complete, no overlap of construction schedules on different Project offshore components would occur.

During each TYMS installation, Delfin LNG anticipates employing a workforce of 79 workers per month (average) for 3.5 months until the work is complete. The workforce would peak at approximately 138 workers. This small number of workers would not impact the populations in the impact area if they were to move there temporarily. Also, very few, if any, would bring householders because of the short duration of the work.

During each FLNGV installation, Delfin LNG anticipates employing a workforce of 150 workers per month (average) for 4.5 months until the work is complete. The workforce would peak at approximately 200 workers. This number of workers, though larger than the workforces required for the other facilities, would not likely impact the populations in the impact area if they were to move there temporarily. Furthermore, it is anticipated that most workers hired during installation would not move, even temporarily, from their existing residences. Also, very few, if any, would bring householders because of the short duration of the work.

Multiple factors indicate that most workers would not move from their existing residences, even temporarily, while employed during installation of the proposed Project offshore components. The Applicant anticipates hiring 90 percent of the workers for the offshore components of the Project from the Gulf region, mainly Texas and Louisiana, given the extensive offshore oil and gas industries in those states and associated labor forces. Because of the extended shift schedules commonly employed for work offshore workers from the Gulf region (mainly Texas and Louisiana) would most likely maintain their existing residences and use their extended "off" period for the commute. Delfin LNG anticipates employing a 14-day on/14-day off work schedule for all offshore workers, whether hired for installation of pipelines, TYMSs, or FLNGVs. The remaining 10 percent of workers who would be hired from outside the Gulf states may move to the impact area temporarily or may commute back and forth from their existing residences. At most, this would be 17 workers during peak construction of the pipeline, 14 during peak installation of a TYMS, and 20 during peak installation of a FLNGV. If these workers' temporarily moved to the impact area, their impact on the population would be negligible.

Construction of the proposed DOF would occur during two stages: one 13-month stage and a second 10-month stage, with a 14-month break in between. The workforce would average 70 workers per month during each construction stage, peaking at 170 individuals for 3 months during each stage, and the average length of employment would be 6 months. Delfin LNG anticipates hiring 65 percent of the proposed DOF construction workforce locally with 35 percent of the workforce moving to the area temporarily.

Overall, impacts on population and demographics during construction would be negligible.

Housing

Workers hired during the construction periods of all of the proposed Project offshore components would work extended shifts of 14 days on/14 days off and would have sufficient time to commute back and forth between their existing residences, if desired. Delfin LNG anticipates hiring the majority (90 percent) of workers during installation from the Gulf region, primarily Louisiana and Texas. For these reasons, few workers are expected to temporarily move to the impact area during installation periods. The workers that choose to temporarily move closer to the proposed Project site would have a negligible impact on housing in the impact area, given the high rental vacancy rates and high numbers of vacant units, hotels/motels, and RV parks relative to the number of workers expected to be hired from outside the region (up to 17 workers during pipeline installation). Even if all workers temporarily moved to the region during installation periods, their overall impact on housing in the impact area would be negligible (not more than 165 workers employed at any one time).

Employment and Income

During subsea pipeline installation of both the proposed bypass and the proposed laterals, the Applicant anticipates hiring 90 percent of workers from the Gulf region, mainly Texas and Louisiana, given the extensive offshore oil and gas and support industries in those states and the associated labor forces. This equates to 69 regionally hired workers per month with 148 workers during peak construction. An additional eight non-regional workers would be hired per month with 17 during peak activity. Jobs would be relatively high-paying with wages equivalent to $75,000/year. The duration of the pipeline installation work would be short-term, lasting approximately 7.5 months, with the average worker's duration of employment lasting 80 days.

During installation of each TYMS and FLNGV, the Applicant anticipates hiring 90 percent of workers from the Gulf region, mainly Texas and Louisiana, given the concentration of specialized oil and gas and marine-related workers in this region. During each TYMS installation, Delfin LNG would employ 71 regionally hired workers per month with 124 workers during peak installation. An estimated 14 workers would be hired from outside the region during peak installation activity of each TYMS. During each FLNGV installation, Delfin LNG would employ 41 regionally hired workers per month with 48 workers during peak installation. An estimated five workers would be hired from outside the region during peak installation activity of each FLNGV. Workers on the TYMS installation would earn monthly wages equivalent to $75,000/year, and workers on the FLNGV installation would earn monthly wages equivalent to $98,280/year. The installation period of each TYMS and FLNGV would be short-term, approximately 3.5 months and 4.5 months, respectively, but a new TYMS and FLNGV would be installed every year for 4 years.

As shown in Table 4.18-1, construction of the proposed DOF would result in a total payroll increase of $10.0 million with an average annual salary of $87,000.

As stated in Section 2.2.8.2, Delfin LNG would construct a new community center in Johnson Bayou, Louisiana, to replace the existing community center located at the site of the proposed DOF. Construction of the new community center is expected to take 5 to 8 months. Workers required to construct the new community center would be typical of similar small commercial or large residential structures in the region. Typical crews would range from 6 to 15 workers on site at any given time.

The employment and income benefits of construction of the proposed Project components, including the proposed DOF, bypass and laterals, TYMS, and FLNGVs, as well as the new community center, would result in short-term, moderate, beneficial impacts in the region.

Land-Based Recreation and Tourism

As discussed in Section 3.3.6, land-based recreation and tourism opportunities in the proposed Project area are limited to the Johnson Bayou Community Center. The center would be relocated prior to the start of construction as the Applicant intends to use this site and building for office space. Additionally, because onshore construction would take place entirely on previously disturbed land that is currently or has been formerly used for industrial activity, the impact on land-based recreation and tourism opportunities would be negligible. Visitors onshore would view ordinary ship traffic to and from the proposed Project and the on-shore construction base.

Public Services

Installation of the proposed Project could potentially impact local public service providers if the proposed Project's workforce and/or householders exceeded providers' capacity; however, given the small number of workers expected to relocate to the impact area during installation, their impact on medical and safety services and public schools in the community would be negligible. The workforce associated with installation activities would be small (up to 165 workers during peak construction), and only a small percentage of workers are expected to move near the proposed Project site temporarily. The duration of each installation period would be short-term, approximately 7.5 months for all pipeline installation, and 3.5 and 4.5 months for installation of each TYMS and FLNGV, respectively.

Deliveries of construction and installation materials associated with the TYMSs would not constitute a major increase in roadway traffic, in part because of the phased construction sequence. Installation of each TYMS and FLNGV would last 3.5 and 4.5 months, respectively, with a 12-month break between installation of each successive TYMS or FLNGV. The phased installation of these offshore components would mitigate land-based traffic increases associated with transport of goods, equipment, and personnel.

Also, the TYMSs would be transported by barge directly to the sites of construction, avoiding impacts on roadways. The FLNGVs would likely be constructed in foreign shipyards and sail under their own power directly to the proposed installation locations offshore. Because the vessels would be built in a foreign country, there would be no local land-based transportation impacts from construction of the FLNGVs.

The offshore pipeline would be delivered by barge directly from its site of manufacture to the proposed construction site. The offshore pipeline would be installed over approximately 7.5 months, so land-based delivery of any miscellaneous construction materials delivered by truck would be limited to approximately that period. Given that the primary construction components would be delivered by barge, and given that delivery of construction materials required for the proposed Project would be spaced apart, roadway improvements are not expected to be required to maintain roadway condition and capacity.

The peak workforce (165 workers) during offshore pipeline construction could overlap with the peak workforce (138 workers) associated with the first TYMS installation in the first year of construction. These construction peaks are not currently scheduled to overlap but, being conservative, it is assumed that the highest number of offshore workers would be 303 for approximately 2 months. These offshore workers would work in shifts (14 days on/14 days off), thus not all 303 workers would travel on the same days to their point of embarkation before being transported to their assigned offshore construction site. The vehicle trips generated by this peak workforce would not constitute major traffic increases because of their relatively small number, staggered sequencing, and short duration (two months). Also, their work assignments offshore for 14 days at a time would limit each individual worker's total number of trips.

After the first year of construction, the offshore crews would peak at 138 workers for no more than a few months during the next three years of construction. Again, these offshore workers would work in shifts (14 days on/14 days off) and their trips are likely to be staggered. Their offshore shift work would also limit their vehicle trips. During the fourth and final year, offshore construction would peak at 53 workers. These workers' vehicle trips would constitute a negligible increase in traffic.

Overall, impacts on public services during construction would be negligible.

4.18.1.2 Impacts of Operation

Shore-based operations would be provided from an operations center selected during the initial construction phase and would consist mainly of office space for 64 workers who would manage and oversee operations. Delfin LNG anticipates that the operations center would be located at an existing site in Cameron, Louisiana. At this time, one helicopter flight per week is anticipated. One helicopter flight could be used to transport key personnel and/or service technicians to several FLNGVs, if required. Offshore workers would be transported from an existing offshore vessel base in Cameron, Louisiana and/or one of several existing helicopter bases in the Cameron, Louisiana area. Delfin LNG has no plans to establish any new facilities or associated parking to support offshore operations at the FLNGVs.

Population and Demographics

As shown in Table 4.18-2, the majority of the workforce hired during operation would be the crew members stationed on the FLNGVs, approximately 416 total employees at full build out. Because of the mariners' shift schedules, the majority of crew members would likely maintain their existing residences, regardless of the distance, and use their extended off-periods to commute back and forth. This is the typical pattern observed in the industrial maritime industry. The remaining workers that moved themselves and their households to the impact area would have a negligible effect on the population.

The shore-based team would consist of 64 employees. Given this small number, the impact on population and demographics would be negligible, even if all of the employees relocated to the proposed Project area.

The proposed DOF would be staffed by nine full-time workers, working in shifts. Delfin LNG anticipates that 50 percent of these workers would be hired from outside of the region and would move to the proposed Project area.

Housing

As discussed above, the majority of the workforce hired during operation would be the crew members stationed on the FLNGVs. Given the shift schedule, it is typical in the maritime industry to maintain one's existing residence regardless of the distance from the offshore work. Even if all the employees moved to the impact area permanently during the operation phase, their impact on housing supply would be negligible given the 28,084 vacant units in Cameron and Calcasieu Parishes, Louisiana, and Orange and Jefferson Counties, Texas (Table 3.18-3).

Approximately 80 percent of the 64 team members needed for shore-based operations are expected to be hired from outside the region (including Texas and Louisiana). Therefore, the majority are expected to move with their householders to the future location of the shore-based facility near the proposed Project. Using the average U.S. household size of 2.58 persons, the approximate number of shore-based team members and householders would be 165 persons. If all moved to the impact area permanently, their impact would be negligible given the 28,084 vacant units in Cameron and Calcasieu Parishes, Louisiana, and Orange and Jefferson Counties, Texas (Table 3.18-3). Even if they moved to a more localized area, their impact would not be major because of their small number compared with the average size of communities (Table 3.18-2).

Employment and Income

As shown in Table 4.18-2, Delfin LNG would employ a total of 480 workers during operation for the offshore components, including 416 employees to crew the FLNGVs and 64 employees to staff the shore-based team. The FLNGV crewmembers would be trained mariners with a variety of specialized skillsets; hence, Delfin LNG anticipates hiring mariners from the United States and other countries. Delfin LNG estimates hiring 70 percent of the FLNGV mariners from the United States, given the available labor supply in the United States and efforts to maintain and enhance training opportunities. At least some portion of the domestic hires would be from the Gulf region, given the relatively high percentage of sailors, marine oilers, and ship engineers in Louisiana and Texas. The crew aboard each FLNGV would include two trainees at all times, to continually build a workforce that would sustain operation for the life of the proposed Project. The trainee positions would likely be filled by local or regional workers a large percentage of the time given their proximity to the proposed Project. The average annual salary of the staff aboard the FLNGVs would be $103,000. In all, approximately 291 of the FLNGV crew are projected to be U.S. workers. These employment impacts on the U.S. maritime industry and workforce would be long-term, beneficial, and moderate.

The shore-based team would include highly specialized workers; hence, 20 percent would be hired from the region, and 80 percent would be hired from other areas of the United States or abroad. This equates to approximately 13 employees hired from the region, and 51 hired from the remaining U.S. states or abroad, for a total of 64 shore-based operations staff. The operations base would be selected during the initial construction phase and consist mainly of office space for the shore-based staff. The average annual salary of the shore-based staff would be $129,000. The jobs would be long-term, high-paying opportunities within the maritime community. Support vessels and tugs hired during the course of operations would base out of the Calcasieu Ship Channel or Sabine-Neches Waterway, providing employment opportunities to tug and vessel operators locally. A number of support vessels and tugs would be part of the existing fleets operating out of those waterways, while others may be new vessels created as a result of the proposed Project. Both would be positive opportunities for new and existing port and maritime workers. Planned maintenance of the FLNGVs would require campaign crews. Four FLNGVs would generate enough ongoing maintenance needs to employ approximately 20 full-time workers divided into campaign crews. These campaign crews would rotate permanently between the four vessels and either be directly employed by the operator company or via a frame agreement placed with a local service provider, which would then provide permanent campaign crews for several years at a time (e.g., 3 to 5 years). Either way, the campaign crews would essentially be permanent crew, and these would also be direct jobs created during operations. Vessels would transport the approximately 416 permanent crew, 20 maintenance workers, and associated equipment back and forth between the proposed Port and shore. The ongoing employment and business opportunities for vessel transport services in the local and regional area would be major.

As shown in Table 4.18-2, employment of the nine full-time workers for the proposed DOF would result in an annual payroll increase of $1 million, with an average annual salary of $85,000.

Overall, employment benefits from the operation of the proposed Project would have a long-term, moderate beneficial, and direct impact on the maritime industry workforce in the Gulf region and the United States, and at least a moderate positive impact on local and regional employment.

Land-Based Recreation and Tourism

As discussed in Section 3.15.6, land-based recreation and tourism opportunities in the proposed Project area are limited to the Johnson Bayou Community Center. No impacts on land-based recreation and tourism are expected as a result of operation of the proposed Project. Visitors onshore would view ordinary ship traffic to and from the proposed Project and the onshore operation base. As discussed in Section 2.2.8.2, a new community center would be constructed in Johnson Bayou, Louisiana, with similar amenities as the existing center.

Public Services

The proposed Project is not expected to impose major burdens on public services or housing supplies. Because of the mariners' shift schedules, most would maintain their households in their existing locations, and the number of shore-based team members is small enough that their use of public services would be negligible. Also, the proposed Port's location offshore would limit its potential burden on public services in the area. The small number of proposed DOF workers that would move to the proposed Project area is not expected to result in a significant increase in demand for public services.

During operation, the shore-based team of 64 workers, working in shifts, would add negligible trips to roadways, regardless of where the shore-based office is located. The shore-based office would be permitted according to State and local regulations, which typically require demonstration of adequate parking for the use category and square footage of the site.

The estimated 416 offshore workers, working in shifts of 21 days on and 21 days off, would be transported to and from the FLNGVs via crew boats. Workers who live overseas or in other parts of the United States would travel to the region by plane; shuttles and other pick-up services would be arranged to transport workers from airports or hotels to a selected port or marina. The vehicle trips generated by transporting these workers would be minimal; each worker would be using roadways only periodically through the year (once every 21 days), workers' shifts would be staggered to some extent, and some workers would carpool, depending on their shift schedule. Workers hired from the local area would not contribute major roadway traffic transiting back and forth from the crew boat base. Given the small number of trips generated by the workforce, existing roadway infrastructure is not expected to require additional roadway improvements that are not already part of existing roadway plans to maintain its condition and capacity.

Overall, impacts on public services during operations would be negligible.

4.18.1.3 Impacts of Decommissioning

The Applicant anticipates that a maximum crew size of 40 personnel would be required to abandon the proposed DOF when the proposed Project is decommissioned. The crew size would range from 20 to 40 workers over the 5 months of decommissioning work. The Applicant anticipates that the workforce required to decommission the proposed Port would have temporary, negligible effects in the impact area that would be similar or less than those anticipated during the construction period. It is expected the proposed Port would be in operation for at least 30 years. Potential socioeconomic impacts would be reassessed prior to decommissioning based on conditions and regulations at that time.

4.18.2 Offshore Economic Conditions

Potential impacts on offshore economics during construction, operation, and decommissioning would result from seafloor disturbance activities, noise, and the Safety Zone, which would produce minimal or negligible, adverse impacts on commercial and recreational fisheries, marine-based tourism and recreation, marine commerce and shipping, and other offshore resources.

4.18.2.1 Impacts of Construction

Generally, impacts would be short-term and minor with marine species returning to the proposed Project shortly after construction. No major disturbances from construction would extend beyond the proposed Project footprint, thereby minimizing impacts.

As the proposed Project leverages existing seabed assets for much of its physical presence on the seabed, the impacts of construction on other ocean uses, including commercial fishing and marine commerce, would be minimal. In the two locations where more traditional construction operations would occur, including the proposed WC 167 bypass and the proposed Port facilities and associated laterals, impacts would be negligible with respect to offshore economic conditions.

Marine-Based Tourism and Recreation

Recreational activities in and around the proposed Project area are very limited due to the dearth of the required facilities to support recreational vessels in southwest Louisiana. Activities such as wildlife viewing, diving, and recreational angling are centered in other parts of the Gulf coast. The few recreational vessels that may be impacted by increased vessel traffic associated with construction operations can shift their destinations or transit corridors slightly to avoid the proposed construction activity while remaining in very similar waters; therefore, impacts on marine-based tourism and recreation associated with construction of the proposed Project would be minimal.

Aesthetic impacts due to construction would be short-term and minor and would be similar to existing ship traffic in the proposed Project area. Aesthetic impacts are not expected to impact marine-based tourism and recreation.

Recreational Fisheries

The proposed Project has the potential to impact recreational fishing and boating due to increased activity in the proposed Project area during construction; however, no major impacts are expected within the commercial or recreational fishing sectors due to construction because the proposed Project area is not an area that is highly valued by the recreational fleet. Any and all displacement that may occur would simply shift recreational fishing efforts to similar locations located near the construction operations. It should be noted that this area of the Gulf coast has very few appropriate ports or other shore side facilities (boat ramps, marinas) to support such activity. The primary bases of operations for recreational fishing and boating in this region are located in the Mississippi delta. For example, and more specifically, Venice and Empire, Louisiana. Alternatively, these facilities are found in large volume in and around Galveston, Texas as well. It is, therefore, intuitive that these operations would continue as normal from these delta and Texas ports with little to no impact from the proposed Project. Lastly, Figure 3.7-2 (in Section 3.7) serves as an example that anglers from Galveston, Texas, and surrounding ports do indeed target fish in and around the proposed Project area. The map also shows, however, that there are hundreds of other fishing locations outside of the immediate Project area and that the density of locations is higher nearer to Galveston.

Therefore, if any recreational anglers are temporarily displaced, it is likely that planned fishing trips would go on as planned making use of very similar fishing grounds on areas of adjacent seabed. All normal financial transactions associated with these trips such as hotel stays, retail patronage and charter fees would continue as well.

Commercial Fisheries

The proposed Project area is not an area that is highly valued by the commercial fishing fleet, and any and all displacement that may occur would simply shift recreational fishing efforts to similar locations located near the construction operations. While it has been published that commercial red snapper fishing out of Galveston (by baited multi-hook lines on electric or hydraulic bandit reels) does occur in shipping fairways and in and around petroleum facilities, these operations would also have the ability to shift slightly away from the discrete construction operations to continue their normal operations if necessary.

Furthermore, commercial fishermen who may reside in and around the proposed DOF do not necessarily fish near the offshore portion of the proposed Project. These commercial fishermen likely fish well offshore, away from the boundary of the Dead Zone, and may be hundreds of miles away when they actually land fish based purely on the nature of commercial fishing. No construction activities are planned in the nearshore environment that would impact fishing close to shore. Lastly, if any commercial fishing operations are temporarily displaced during construction or decommissioning, it is extremely likely that any planned commercial fishing trips would go on as scheduled. The captain and crew would locate other grounds to fish outside the proposed Project area and these grounds would be very similar to any perspective areas that the vessel may be temporarily displaced from. The only fishery that would be displaced from the area surrounding and between the ATBAs for the life of the proposed Project is the otter trawl fleet. The total acreage that would be lost to commercial trawling within and between the ATBAs is approximately 10,784 acres.[31]

It may be expected that all regular commercial fishing would go on as is normal. These fishermen would sell the catch associated with each trip as well as execute all other associated transactions (e.g., fuel, provisions). All fishermen, engineers, captains, and crew should continue to operate as they would absent this construction.

Marine Commerce and Shipping

The commercial shipping activities that could potentially be impacted by construction tasks associated with completing the proposed Port would most likely be to any vessels transiting in and out of the existing petroleum facilities or into or out of Cameron or Sabine Pass, Louisiana, or, to a lesser degree, Galveston, Texas. This area of the Gulf experiences high volumes of petroleum industry-related vessel traffic every day (see Figure 3.2-18 in Section 3.2.8). Be it floating rig transits, tanker traffic or support vessels, an offshore ship is nearly always in transit in the proposed Project area. This activity would continue unfettered and no tangible impacts would be expected on mercantile shipping.

Neither construction location is located within any of the established navigation fairways, and the fairways in and around the proposed Project do not generally serve the main ports of the Mississippi delta. Even vessels bound for southwest Louisiana ports would not be impacted to any major degree by proposed construction operations because these construction locations would be located outside of existing fairways. No foreseeable shipping delays are expected due to the proposed construction activity and therefore all accounts payable and receivable are expected to remain up to date and at a level commensurate with the period of time immediately prior to construction.

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[31] This number was generated based on an estimation of the entire area that would be lost to commercial trawling due to establishment of the ATBAs; however, it should be noted that this is larger than the individual ATBA acreages as it encompasses the area in between the four unique ATBAs.

Other Offshore Resources

The addition of the proposed Project would serve to benefit this industry as both an addition to the existing offshore infrastructure and an efficient repurposing of defunct facilities. Additionally, since construction operations occur in lease blocks that Delfin controls via lease or existing agreement, ongoing petroleum operations in and around the proposed Project area would proceed unfettered. Standard maritime technology and communications should allow each individual entity operating in or around the proposed Project area to operate efficiently throughout the construction period. Major vessel and floating facility mobilizations and demobilizations occur within the petroleum industry here as a matter of course and no offshore mariners are better prepared for offshore coordination than those operating in this portion of the Gulf of Mexico. Overall, no major, detrimental impact on existing other offshore resources is expected due to the proposed Project.

4.18.2.2 Impacts of Operations

The area in the vicinity of the proposed Port would be available for transit and fishing, outside of the Safety Zone, NAAs, and the ATBA during operation. Therefore, operational activities are not expected to impact offshore economic conditions. When vessels make use of the proposed Port, they would do so while remaining outside of the navigational fairways, allowing traditional or increased ship traffic to continue safe passage.

Marine-Based Tourism and Recreation

Impacts on marine-based tourism and recreation during operation of the proposed Project would be negligible due to the siting of the proposed Project in an area currently occupied with oil and gas rigs and other infrastructure. Some vessels would be excluded from certain areas around the proposed Project during operation; although this impact would be long-term, it is expected to be minor due to the minimal nature of marine-based tourism and recreation in the area.

Aesthetic impacts due to construction would be short-term and minor and would be similar to existing ship traffic in the proposed Project area. Aesthetic impacts are not expected to impact marine-based tourism and recreation.

Recreational Fisheries

Impacts to recreational fisheries would be due to establishment of exclusion zones and increased vessel traffic; however, impacts would be negligible due to the siting of the proposed Project in an area with existing offshore infrastructure and minimal recreational fishing activity.

Commercial Fisheries

Commercial fishing vessels traversing in and out of Galveston, Texas, would see minimal interruption to their access to home port facilities. The exclusion areas would be negligible when compared with the available fishing areas throughout the western Gulf of Mexico, and when viewed in light of the minimal presence of commercial fishing activity in the proposed Project area, as compared with areas closer to Galveston, Texas. The only fishery that would be displaced from the area surrounding and between the ATBAs for the life of the proposed Project is the otter trawl fleet. The total acreage that would be lost to commercial trawling within and between the ATBAs is approximately 10,784 acres.[32]

Marine Commerce and Shipping

Impacts to marine commerce and shipping during construction would be due to establishment of exclusion zones and increased vessel traffic. The proposed Port is not locating within any of the

[32] This number was generated based on an estimation of the entire area that would be lost to commercial trawling due to establishment of the ATBAs; however, it should be noted that this is larger than the individual ATBA acreages as it encompasses the area in between the four unique ATBAs.

established navigation fairways; therefore, impacts on marine commerce and shipping would be long-term but negligible.

Other Offshore Resources

Impacts to other offshore resources during operation would be negligible except for the exclusion of certain activities within the proposed Project area, which would result in a long-term impact.

4.18.2.3 Impacts of Decommissioning

Impacts of decommissioning on offshore economic conditions would be similar to, or less than, those expected during construction of the proposed Project. Decommissioning is estimated to take approximately 10 weeks; therefore, any impacts would be shorter in duration than those expected for construction. It is expected the proposed Port would be in operation for at least 30 years. Potential offshore economic impacts would be reassessed prior to decommissioning based on environmental conditions and regulations at that time. An impact assessment for decommissioning the onshore pipeline facilities would be completed by the FERC under Section 7 (b) of the Natural Gas Act when Delfin submits an application to abandon the natural gas pipeline and ancillary facilities.

4.18.3 Impacts of Alternatives

In addition to the proposed Project, alternative port designs, cooling media, anchoring systems, DOF locations, and compressor station designs were evaluated. A No Action Alternative was also evaluated.

4.18.3.1 No Action Alternative

The No Action Alternative is considered to be the continuation of existing conditions of the affected environment without implementation of the proposed Project. Under the No Action Alternative, the Maritime Administrator would deny the license, or the Governor of an adjacent coastal state would disapprove the Project under the DWPA, or the applicant could withdraw the license application. Any of these actions or the disapproval of any other permitting agency could result in the Project not proceeding. This would mean that the proposed Port and the associated pipelines and compressor station would not be constructed. Accordingly, none of the potential environmental impacts, either positive or negative, associated with construction and operation of the proposed Project would occur.

Other license applications for projects designed to satisfy demand for natural gas exported from the United States might be submitted to MARAD or FERC, and these projects, should they go forward, could have greater, lesser, or similar impacts in comparison with the proposed Project. Other means might be used to satisfy the global energy demands, such as expansion of existing ports or establishment of onshore LNG ports for export from the United States. Because the global demand for energy is predicted to increase in the long term, consumers might have fewer and potentially more expensive options for obtaining natural gas in the near future. It is possible that existing natural gas infrastructure supplying the proposed market area could be enhanced in other ways unforeseen at this point, including further development of natural gas sources in North America and construction of associated pipeline projects. In some cases, potential customers of natural gas could select available energy alternatives such as oil, coal, nuclear, wind, solar, hydroelectric power, or biomass (e.g., wood or corn pellets) to compensate for the reduced availability of natural gas, or may seek energy supply from countries other than the United States. In addition, a portion of the demand might be met through energy conservation. However, it is purely speculative to predict the resulting action(s) that would be taken by the potential end users of the natural gas proposed to be supplied by the proposed Project and the associated direct and indirect environmental impacts of that use.

Under the No Action Alternative, the proposed Project would not be built and there would be no potential for direct or indirect adverse impacts on socioeconomic resources. Furthermore, no jobs would be created and coastal communities would not benefit from the increased revenues from the sale of goods and services to support the proposed Port.

4.18.3.2 Alternative Deepwater Port Designs

Greater seabed disturbance would be expected if a fixed platform-based unit was used and this may result in some additional impact on commercial marine activities; however, impacts would likely be minor due to the localized nature of the disturbance and the short-term duration of the construction period.

4.18.3.3 Alternative Cooling Media

Use of alternative cooling media would have no differentiated impact on onshore economic conditions.

Use of an open-loop, water-cooled system would result in higher levels of impingement and entrainment mortality and additional impacts on marine life at the point of discharge due to temperature rise. This would likely result in additional impacts on recreational and commercial fishing activities in the immediate proposed Port vicinity; however, given that fishing activity is limited in this area, impacts would be minor.

4.18.3.4 Alternative Pipeline Routes

Only the HIOS/UTOS and the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC systems were carried forward as part of this analysis. Use of the Natural Gas Pipeline Company, LLC/Stingray Pipeline Company, LLC system would not require any greenfield construction; therefore, there would be slightly reduced impacts on socioeconomics associated with use of this alternative as the extent of construction would be reduced, both positive impacts due to economic benefits and negative due to exclusion from certain marine areas. Impacts on socioeconomics during operation and decommissioning of the proposed Project would be similar regardless of which pipeline was selected.

4.18.3.5 Alternative Port Locations

Three alternative port locations were considered for this analysis (see Figures 2.3-3 and 2.3-4). The increased distance of 10 to 15 nautical miles offshore of Alternatives 2 and 3 as compared to Alternative 1 could result in additional fuel, maintenance, and operational costs that could result in slightly greater economic benefits.

4.18.3.6 Alternative Anchoring Methods

Use of an alternative anchoring system would have no differentiated impact on onshore economic conditions.

It is anticipated that driven piles would have the smallest footprint; therefore, installation of driven piles would result in less of an effect on commercial and recreational fishing. Suction anchors, by virtue of pumping out water from inside the caisson would have an impact on the zooplankton within that water column, which the other alternatives avoid. Gravity-based anchor structures would result in a direct loss of existing fish habitat in approximately 2,500 ft^2 per anchor structure. However, the gravity-based anchor system structures would provide hard substrate at different depth which would likely result in an artificial reef sustaining development of new biotic communities that have a potential to support marine populations. Such gravity-based anchor reefs would not be available to commercial and recreational fishermen so would not result in any direct positive economic impact. Although selection of an alternative anchoring system may result in additional impacts on the commercial and recreational fishing industry, the minimal level of fishing activity in the proposed Project area would limit any additional impact.

4.18.3.7 Alternative DOF Location

Delfin LNG identified four alternative sites to carry forward in its Tier 2 siting analysis. DOF Alternative #1 is the PSI Cameron Meadows Gas Plant; DOF Alternative #2 is Transco’s Station 44; DOF Alternative #3 is a greenfield location adjacent to the PSI Cameron Meadows Gas Plant; and Alternative #4 is a greenfield location adjacent to Tennessee Gas Pipeline Company facilities on the north side of Highway 82 approximately 1.3 miles east of the three other alternative locations (Figures 2.3-5 and 2.3-6). With regard to socioeconomics, use of any of these four alternatives, or a combination of the sites, would have similar impacts during construction, operation, and decommissioning. The three sites are located adjacent to each other and would impact the same socioeconomic resources regardless of which site is selected.

4.18.3.8 Alternative Compressor Station Design

An alternative compressor station design would have no differentiated impact on socioeconomic resources.

4.18.4 Best Management Practices

Measures discussed in Section 4.8.5 and Section 5.0 to address transportation concerns related to arrival and departure of the FLNGVs and other Project vessels, such as Notices to Mariners, would minimize navigational risks to other vessels transiting the proposed Project area, including commercial and recreational fishermen. No additional BMPs have been identified with regard to impacts on socioeconomic resources as impacts are expected to be largely negligible and beneficial.

4.18.5 Recommendations and Conclusions

Impacts on socioeconomic resources are expected to be largely negligible, and beneficial; therefore, the USCG does not recommend additional mitigation measures to be implemented.

We have determined impacts on socioeconomic resources would be as described in Table 4.18-3.

Table 4.18-3. Summary of Impacts for Socioeconomic Resources

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Construction			
Employment and associated relocation of workers	Pipeline – 77 workers/month for 7.5 months TYMS – 79 workers/month for 3.5 months FLNGV – 150 worker/month for 4.5 months 90% of workers hired from Gulf region; few would relocate to the proposed Project area	None	Negligible
Payment of wages and taxes	Pipeline and TYMS - wages equivalent to $75,000/year with short-term employment FLNGVs – wages equivalent to $98,280/year with short-term employment	None	Short-term, moderate, beneficial
Relocation of Johnson Bayou Community Center	Permanent relocation	None	Negligible
Use of public services	Shift schedule for mariners; Small workforce with short-term employment; minimal relocation; Highest number of offshore workers (303) for only 2 months	None	Negligible
Restricted marine access (Safety Zones, NAAs, ATBAs)	Occasional construction traffic and exclusion zones might result in minor displacement of tourism and recreation during the 5.5-year construction period	See Section 4.8 for BMPs related to marine transportation.	Negligible

Table 4.18-3. Summary of Impacts for Noise (continued)

Aspects of Proposed Action With Potential to Affect Resource	Frequency/Duration	Applicable Best Management Practices	Potential Effect
Disturbance of seafloor and associated fish habitat	Occasional construction traffic and exclusion zones might result in minor negligible, short-term displacement of recreational and commercial fishing activities, marine commerce and shipping, and E&P of other offshore resources, during the 5.5-year construction period	See Section 4.8 for BMPs related to marine transportation.	Negligible
Operation			
Employment and associated relocation of workers	FLNGVs – 416 employees at full build out Shore-based – 64 employees 80% of workers hired from Gulf region; up to 165 people total may re-locate	None	Negligible
Employment and associated relocation of workers	FLNGVs – wages equivalent to $103,000/year Shore-based – wages equivalent to $129,000/year	None	Negligible
Relocation of Johnson Bayou Community Center	Permanent relocation	None	Negligible
Use of public services	Shift-schedule for mariners; minimal relocation; small shore-based team	None	Negligible
Restricted marine access (Safety Zones, NAAs, ATBAs)	The Port and exclusion zone could displace recreational and commercial fishing, marine commerce, and other offshore activities	None	Long-term, negligible-minor, adverse
Decommissioning			
It is expected the proposed Port would be in operation for at least 30 years. Potential impacts on biological resources would be reassessed prior to decommissioning based on environmental conditions and regulations at that time.			

4.18.6 Environmental Justice Impacts

EO 12898, *Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations*, provides that each agency shall integrate environmental justice into its mission by identifying and addressing, as appropriate, disproportionately high and adverse human health or environmental effects of its program, policies, and activities on minor populations and low-income populations. According to guidance documents prepared by the USEPA and CEQ, the basic components of an environmental justice assessment include:

- a demographic assessment of the affected community to identify minority and/or low income populations that may be present,
- an assessment of all potential impacts of the project to determine whether any would result in a significant adverse impact on the affected environment, and

- an integrated assessment to determine whether any high and adverse impacts would disproportionately affect minority and low-income groups present in the study area.

In accordance with EO 12898, this final EIS includes an analysis of the adverse human health or environmental effects, as a result of the proposed Project, on minor populations and low-income populations.

Because of the distance of the proposed Port from the shore, all of the communities would be expected to experience a similar level of environmental impact relative to their size. Further, because of their location offshore, the proposed Port would not be expected to have potential negative environmental impacts on nearby communities, because the nearest communities are located so far way. Moreover, the broader socioeconomic impacts of the proposed Project are expected to be positive, stimulating the local maritime economies and providing skilled job opportunities in a variety of fields.

Potential onshore impacts during construction, operation, and decommissioning would be limited to viewscape alterations; however, given the existing viewscape is currently populated with oil and gas infrastructure, impacts are expected to be negligible.

Overall, the proposed Port is not expected to have disproportionate impacts on minority or low-income communities compared with other communities nearby.

5.0 SAFETY

5.1 Introduction

The transportation, handling, storage, and processing of liquefied natural gas (LNG) and transportation of associated natural gas requires strict controls to minimize potential risks and interruptions of gas supplies. This section provides an overview of issues that would affect the safe and reliable operation of the proposed Port Delfin LNG Project (Project). This section is limited to design, engineering, and operational components of the proposed Project's infrastructure that, directly or indirectly, would have the potential to affect public safety. Reliability of overseas LNG supplies and shipping is outside the scope of this final Environmental Impact Statement (EIS). Safety of personnel working onboard the proposed Port facilities, including process safety and vessel operations, is addressed in International Maritime Organization (IMO) Conventions and U.S. regulations and would be fully addressed in the U.S. Coast Guard (USCG)-approved Deepwater Port Operations Manual prior to commencement of operations, and is also beyond the scope of this draft EIS.

If the Port Delfin LNG deepwater port is approved, the USCG is responsible for review and approval of the design basis, fabrication, construction, installation, commissioning, operations, security, maintenance procedures, and inspection of port components. This includes Management of Change to review and approve any proposed substantive changes to port operations or equipment or environmental impact. In addition, the USCG would ensure coordination with appropriate and responsible agencies such as the Maritime Administration (MARAD) for licensing issues, the U.S. Department of Transportation's (DOT) Pipeline Hazard and Safety Administration (PHMSA), the Bureau of Ocean and Energy Management (BOEM) and Bureau of Safety and Environmental Enforcement (BSEE), and environmental resource agencies for the life of the port and eventual decommissioning.

The Federal Energy Regulatory Commission (FERC) is the lead agency responsible for certificating the onshore components of the Project including the requirement that an applicant certify that it will design, install, inspect, test, construct, operate, replace, and maintain the facility for which a Certificate is requested in accordance with Federal safety standards and plans for maintenance and inspection promulgated by the DOT and administered by the PHMSA.

The information, figures, and tables associated with LNG release and spill consequence analysis in this section of the draft EIS are derived primarily from the Delfin LNG Project Spill Consequence Analysis Report of May 9, 2016, prepared by Risknology, Inc. (Risknology) for Delfin LNG. The original report was included as confidential in the original and amended applications. The USCG requested that Delfin LNG make the initial report publically available, with which Delfin LNG agreed, and then the USCG had Sandia National Laboratory (Sandia) review the report. The May 9, 2016, version includes incorporation of some of the applicable Sandia comments and is included in its entirety in Appendix Q of this final EIS.

5.2 LNG Hazards

5.2.1 Physical Properties

LNG is approximately 95 percent methane (natural gas) in liquid form. When the gas is cooled to -260 degrees Fahrenheit (°F) (-162 degrees Celsius [°C]), it decreases in volume and becomes a clear and odorless liquid. LNG is transported and stored at near atmospheric pressure. As the liquid vaporizes and expands to form a gas, a pressure slightly above atmospheric pressure is maintained. This elevated pressure precludes air from entering the storage container.

LNG has several physical properties that are of interest:

- LNG is not toxic, but can act as an asphyxiant by displacing air;

- when initially released, cold LNG vapor remains heavier than air until it warms up and becomes buoyant;
- natural gas at normal temperature (60°F, or 15.6°C) and pressure (one atmosphere) is lighter than air;
- natural gas at ambient temperature occupies 625 times more volume than LNG (methane liquid);
- when mixed with air, natural gas is flammable within the range of 5 to 15 percent. Outside this range, the gas is either too lean or too rich to support combustion;
- compared to some other hydrocarbon fuels, natural gas has among the highest auto-ignition temperatures (e.g., higher than liquefied petroleum gas, gasoline, and diesel); and
- when spilled on water, a rare event known as rapid phase transition (RPT) can occur as the LNG very rapidly (near instantaneous) vaporizes from its liquid phase to its gaseous phase, resulting in a localized overpressure.

Methane, the primary component of natural gas, is colorless, odorless, and tasteless. It is not toxic, but is classified as a simple asphyxiant, possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death.

Methane has an auto-ignition temperature of 1,000°F (538°C) and is flammable at concentrations between 5 and 15 percent in air. Experience and testing indicate that unconfined natural gas vapor clouds do not explode. As the degree of confinement and congestion in the area surrounding a leak increases, the potential to explode rather than to flash also increases (Lees 1996). A vapor cloud, within the flammable range, located in a confined space can explode. In all cases, LNG vapors must be within the flammable range and an ignition source must be available (Juckett 2002). In the absence of an ignition source, a potentially flammable plume would migrate from the LNG leak source until the leak is isolated or until the LNG supply is exhausted and the air dilutes the concentration of natural gas to below the lower flammability limit (LFL). Due to the physical properties of natural gas, the gas cloud would quickly become buoyant.

Regardless of the cause, the formation of a methane/air mixture and its movement depends on the quantity and rate of the spill, whether it is on land or water, the atmospheric stability, the wind direction and velocity, and the temperature of the atmosphere and water.

There are five major hazard conditions associated with LNG that could have significant impacts over wide areas:

- thermal radiation (flux) hazards,
- LNG pool fires,
- flammable vapor clouds,
- cryogenic hazards, and
- RPT.

5.2.2 Thermal Radiation (Flux) Hazards

Thermal radiation (flux) hazards can result from ignition of an LNG pool or ignition of a flammable LNG vapor cloud. Thermal radiation is the heat felt from the source. Hazards to humans include burns ranging from first degree to third degree, and can result in moderate to severe injury or death. The degree of a thermal radiation hazard is dependent on a number of factors, including distance from the thermal radiation source, exposure time, and shielding via personal protective equipment or structures. For human skin exposure to thermal radiation, a thermal flux of 1,600 British thermal units per hour per square foot ($Btu/hr/ft^2$) (5 kilowatts per square meter [kW/m^2]) would result in unbearable pain after an exposure of 13 seconds and second degree burns after an exposure of 40 seconds. Other thermal (fire) related hazards to humans include smoke inhalation and asphyxiation due to lack of oxygen.

In addition to human injury and fatalities, hazards to vessels and equipment are also possible due to thermal radiation. Literature reviewed indicates thermal flux levels of 11,900 Btu/hr/ft^2 (37.5 kW/m^2) can cause damage to steel tanks and process equipment. Thermal radiation hazards could be the result of either LNG pool fires or ignition of an LNG vapor cloud, which are further discussed below.

5.2.3 Pool Fires

Any rapid release of LNG from the floating liquefied natural gas vessel (FLNGV) onto water could result in a pool fire. In the event of a release, the LNG would float on top of the water and a pool would form. Heat from the seawater would warm the LNG pool and release vapors of natural gas to the atmosphere. A pool fire could occur in cases where methane, rising from the surface of the pool, combines with the proper mixture of oxygen (Section 5.2.4) and comes into contact with an ignition source. A large pool fire scenario is likely to be the highest risk in terms of the size of the thermal radiation hazard zone. Predictions regarding LNG pool fires are based on mathematical modeling and limited small-scale experiments, as there is no recorded instance of a large release of LNG on water or a resulting pool fire.

5.2.4 Flammable Vapor Clouds

LNG is less dense than water. If spilled and exposed to the atmosphere, it would absorb heat from the seawater and ambient air, initially forming a cold, heavier than air cloud that would be visible due to condensed moisture within the air. Because of the material's density and the turbulence created by the rapid boiling, an LNG spill would spread and vaporize rapidly. The initial cold air and LNG gas mixture is not buoyant between -260°F and -162°F (-162°C and -107°C). In the natural gas cloud, the amount of gas mixing with air would not be uniform, and pockets of the flammable gas/air mixture might exist in regions of the cloud that are generally outside the flammability limits of methane. If this flammable plume encounters an ignition source, a fire would flash back to the source of the spill, causing potentially serious burns to individuals within the flammable concentration zone. Sustained development and dispersion of a flammable vapor cloud is less likely to occur due to high probability that an ignition source would be present at the LNG spill resulting in a pool fire.

Thermal radiation is the primary mechanism of heat transfer from the burning methane to an individual or structure. When LNG initially vaporizes from its liquid state to its gaseous state, the methane concentration is high, resulting in insufficient oxygen levels to support combustion. When the concentration of methane decreases to approximately 15 percent of the vapor/air mixture (15 percent methane, 85 percent air), it would burn. This is known as the upper flammability limit (UFL). As the vapor continues to mix with more of the surrounding air, its concentration continues to decrease.

The LFL for methane is approximately 5 percent (5 percent methane, 95 percent air). When the mixture is diluted to concentrations below 5 percent, it becomes too lean to burn.

When an unconfined cloud containing a natural gas/air mixture burns in the open, the flame generally spreads from the ignition source back over the surface of the LNG vapor cloud. The flame's speed is only a few miles per hour. This flame speed is too slow to generate an explosion. Instead, the flame burns back to the source, and the primary concern is the radiant heat generated from the fire and the flames themselves. For LNG to cause an explosion, the vapor cloud must be confined. Large-scale field tests determined that releases of methane into the open air or onto water would not explode if ignited. Any methane that does not burn after being diluted below its LFL would dissipate into the atmosphere.

5.2.5 Cryogenic Hazards

As a cryogenic liquid, LNG quickly cools the materials it comes into contact with and causes extreme thermal stress in materials not specifically designed for ultra-cold conditions. These thermal stresses can cause brittleness or loss of tensile strength, and possible fracture of common materials of construction.

Regarding worker safety, potential hazards include exposure to low temperature LNG and asphyxiation by concentrated vapors. The low temperature is sufficient to rapidly cause the equivalent of frostbite or, if enough of the body surface is exposed, death via freezing of the tissue.

The time frame for these potential impacts is limited. Even though the LNG vapor cloud is not toxic, the cloud might displace enough air to make the atmosphere unsafe for humans to breathe. This represents a hazard to the personnel in close proximity to the release, especially if there is some confinement that traps the vapor and allows the concentration to build up in the area.

5.2.6 Rapid Phase Transition

RPT occurs when LNG comes in direct contact with warmer water. In some cases, the rapid uncontrolled expansion of LNG as it changes from a liquid to a gas could result in a localized explosion caused by the physical energy released during the rapid expansion of the liquid to gas (Lees 1996). The hazard zones extending from an RPT are highly localized within or in the immediate vicinity of the spill area. RPT accidents, since considered to be negligible and highly localized, are probably of lower concern as compared to these other LNG-related hazards (Havens 2003). Since 1981, there have been several projects sponsored by the Society of Petroleum Engineers to investigate and develop a methodology for producing quantified estimates of the risk associated with the RPTs. Progress from this work is reported periodically in the *Journal of Petroleum Technology*.

5.3 Evaluation of Public Safety

For the purposes of this section, the public is defined as non-Project-related people. Delfin LNG is required to address the safety of Project personnel by complying with the regulations applicable under the Deepwater Port Act of 1974 (DWPA) and other applicable laws and regulations. The DWPA regulations require Delfin LNG personnel to be educated on the hazards involved in the proposed Project's operation, trained in proper emergency and evacuation procedures, outfitted with appropriate personal protective equipment, and comply with other contingency plans and safety measures. Many of the detailed contingency plans and safety protocols have not been developed at this phase of the DWPA licensing process. Such details are required to be included in the Applicant's Deepwater Port Operations Manual, which must be approved by the USCG prior to commencement of deepwater port operations. Therefore, this section considers hazard scenarios based on their potential to impact the public.

5.3.1 Safety Review Criteria

Potential safety impacts to the public from any deepwater port would come from an accidental or intentional release of LNG generating a pool fire or flammable vapor dispersion cloud.

5.3.2 Credible Range of Release Scenarios

The extent of fire or vapor dispersion is based on varying breach sizes and number of tanks affected from accidental or intentional scenarios (i.e., collision or terrorist act) and site-specific metocean conditions as previously reported by Sandia. With information derived from the Delfin LNG Project Spill Consequence Analysis prepared for Delfin LNG by Risknology (see Appendix Q), hazard distances from various breach sizes are presented.

See Section 5.4 for additional information regarding the credible range of release scenarios.

5.3.2.1 Site-Specific Input Data

Site-specific input data are normally used in completing the risk analysis, which incorporates such things as design information, size of the FLNGVs and transiting LNG carriers (LNGCs), operations, storage, and metocean data. Because the Project would be approximately 40 nautical miles from shore, the Sandia report guidance was used for determination of breach sizes and number of tanks impacted (Sandia 2008).

Because of the proposed Port's location far offshore, detailed vessel traffic analysis was not conducted and the worst credible scenario, though not considered likely according to the 2008 Sandia Report, was assumed to be a cascading event of a 129 square foot (ft^2) (12 square meter [m^2]) three-tank breach to provide a conservative estimate of concerns.

5.3.2.2 Direct Impact on the Public

The purpose of the public safety evaluation is to review the proposed Project's potential safety and security impacts on the public and property in the subject area of the proposed Port facilities. The LNG Spill Consequences Analysis considers potential direct impacts on humans and property from a potential worst-case(s) release of LNG from the proposed Port facilities. Indirect impacts on the public and property (e.g., economic impacts resulting from an LNG release) will not be considered in the public safety evaluation. Also, project-related property and safety evaluation will not be included in this study.

5.3.2.3 Bounding Case (Worst Credible Impact)

The vapor cloud from a 388 ft^2 (three times a 12 m^2) cascading three-tank breach of LNG release from Delfin LNG's FLNGV #2 or also likely FLNGV #4 location could potentially reach the Sabine Pass Safety Fairway with obvious impact to shipping traffic. See Section 5.4.3.5 for additional information and risk mitigations.

5.3.3 Sandia National Laboratory Guidelines

In 2004, the DOE commissioned Sandia to develop a risk-based analysis approach to assess and quantify potential hazards and consequences of an LNG spill from an LNGC.

Sandia utilized previously completed studies and conducted its own studies to determine the hazards of an LNG spill. Sandia also developed risk management strategies to minimize the likelihood of an incident. The 2004 Sandia report—*Guidance on Risk Analysis and Safety Implications of a Large Liquefied Natural Gas (LNG) Spill Over Water* (Sandia 2004)—is typically used as the industry standard and benchmark on which to base project-specific risk assessment studies.

Because of the increasing size and capacity of many new LNGCs, at the request of the DOE, Sandia conducted a detailed breach analysis, *Breach and Safety Analysis of Spills Over Water from Large Liquefied Natural Gas Carriers* (Sandia 2008), for large LNGCs ranging up to 9,358,387 ft^3 (265,000 m^3). Based on the analysis, the range of breach sizes calculated for credible intentional scenarios appropriate for nearshore operations, where there is waterway surveillance, monitoring and control, ranged between 22 to 129 ft^2 (2 to 12 m^2). For offshore operations, where there is less control and surveillance of ship operations, credible intentional scenarios can be larger and the calculated breach sizes can range from 54 to 172 ft^2 (5 to 16 m^2), with the most likely or nominal intentional breaching scenario resulting in an LNG cargo tank breach of approximately 129 ft^2 (12 m^2) (Sandia 2008; see discussion and accompanying tables in Section 5.4). In their 2008 report, Sandia concluded that, in general, the worst-case LNGC breach scenario with hazards to public safety and property would be within approximately 7,536 ft (2,297 m) of a spill, with minor damages reaching as far as 21,573 ft (6,575 m). However, they recommended a project-specific risk assessment to determine hazard distances. Therefore, based on the Sandia 2008 report conclusions, there is minimal risk to public safety and property from a larger LNGC given the location of the proposed Port.

5.3.4 Impacts on Public Safety and Property

The proposed Port would be located approximately 40 nautical miles from the coast of Cameron Parish, Louisiana, minimizing the potential risk to the general public.

Based on large-scale LNG spill release modeling and the proposed Port's location, a pool fire would not reach the shore, the Sabine Pass Safety Fairway, and other FLNGV locations; however, the vapor dispersion cloud could impact the Sabine Pass Safety Fairway and the other proposed tower yoke mooring system (TYMS) locations. See Section 5.4.3.5 for additional information.

In 2008, Sandia was commissioned by the DOE to conduct a series of large-scale LNG fire and cryogenic damage tests, as well as detailed, high performance computer models and simulations of LNG vessel damage resulting from large LNG spills and fires on water. The 2012 Report to Congress, *Liquefied Natural Gas Safety Research* (DOE 2012), summarized the key findings as follows:

- For the large breach and spill events considered, as much as 40 percent of the LNG spilled from the LNG vessel's cargo tank is likely to remain within an LNG vessel's structure, leading to extensive cryogenic fracturing and damage to the LNG vessel's structural steel. In addition to the cryogenic damage, the heat fluxes expected from an LNG pool fire would severely degrade the structural strength of the inner and outer hulls of an LNG vessel. The extent of the cryogenic and fire damage on an LNG vessel resulting from large spills and associated pool fires would significantly impact the LNG vessel's structural integrity, causing the vessel to be disabled, severely damaged, and at risk of sinking.
- Current LNG vessel and cargo tank design, materials, and construction practices are such that simultaneous, multi-cargo tank cascading damage spill scenarios are extremely unlikely, though sequential multi-cargo tank cascading damage spill scenarios may be possible. Should sequential cargo tank spills occur, they are not expected to increase the hazard distances resulting from an initial spill and pool fire; however, they could increase the duration of the fire hazards.
- Based on the data collected from the large-scale LNG pool fire tests conducted, thermal (fire) hazard distances to the public from large LNG pool fires would decrease by at least 2 to 7 percent compared to results obtained from previous studies.
- Risk management strategies to reduce potential LNG vessel vulnerability and damage from breach events that can result in large spills and fires should be considered for implementation as a means to eliminate or reduce both short-term and long-term impacts on public safety, energy security and reliability, and harbor and waterways commerce. Approaches to be considered should include implementation of enhanced operational security measures, review of port operational contingency plans, review of emergency response coordination and procedures, and review of LNG vessel design, equipment and operational protocols for improved fire protection.

5.3.4.1 LNG Ports

At present, only three LNG import facilities have been built offshore: the Gulf Gateway Energy Bridge Project, which commenced operations in March 2005 and ceased operations in June 2013; Northeast Gateway Energy Bridge Project, which commenced operations in May 2008; and Neptune Deepwater Port, which commenced operations in April 2010 and suspended operations in May 2013. A review of available information indicates there are no recorded incidents regarding impacts on public safety and property caused by deepwater import facilities. A review of available information is therefore limited to land-based LNG import and export facilities and indicates there have been only seven documented incidents with one or more (worker and/or public) fatalities associated directly with operations at land-based LNG facilities: (1) Skikda, Algeria, January 2004; (2) Bontang, Indonesia, 1983; (3) Maryland, United States, 1979; (4) Arzew, Algeria, 1977; (5) New York, United States, 1973; (6) Raunheim, Germany, 1966; and (7) Ohio, United States, 1944. Two of the seven incidents were related to construction or maintenance activities at the LNG facilities and not directly to LNG operations (CH-IV International 2006). See Appendix R for details.

The first U.S. land-based LNG export facility at Kenai, Alaska, shipped LNG to Japan from 1969 through 2013 and then restarted operations in 2015. The Kenai LNG facility has been incident-free for almost 50 years, according to available information. The first LNG export from Cheniere's Sabine Pass, Texas, facility departed for Brazil on February 24, 2016. Since that first delivery, there have been more than 20 shipments from Sabine Pass to South America, the Middle East, Asia, and Europe. Available information for Sabine Pass indicates that there have been no documented incidents associated with export operations at this facility.

5.3.4.2 LNG Carriers

LNGCs are designed, constructed and equipped to carry cryogenic LNG stored at a minimum temperature of -260°F (-162°C). The spherical and membrane types are accepted worldwide as cryogenic cargo containment systems. LNGCs are constructed with spill and accident prevention measures incorporated into equipment design, operations, and safety training (ABS Consulting, Inc. 2004). The transportation of LNG by ship has proven to be an extremely safe method since the first LNG maritime shipment in 1959. Commercial maritime shipments of LNG began shortly thereafter in 1964. In 1980, the USCG determined that the level of risk associated with LNG maritime transportation is acceptable. There has not been any LNG-related loss of life to crews and no LNG-related injury to the public.

More than 135,000 LNGC voyages have taken place, covering more than 100 million miles while loaded, with no major accidents, safety problems, recorded fatalities to vessel crew or the general public, or recorded fires on deck or within cargo areas. Out of the greater than 135,000 shipments of LNG since 1964, eight marine incidents worldwide have resulted in LNG spills. These spills have resulted in some damage to the LNGC, but no LNG fires have occurred (Sandia 2004). The most significant damage resulting from LNG leakage involved a deck or plating fracture from cryogenic embrittlement (CH-IV International 2006). An additional 11 incidents involved a vessel collision, a vessel running aground, or vessel fracture due to high seas deflection stresses. However, none of these 11 incidents resulted in the spillage of LNG (CH-IV International 2006).

As of December 2015, the world's LNG fleet was composed of 373 active LNGC, with another 155 LNGCs on order worldwide (IGC Report). Out of the 68 vessels ordered in 2014, 85 percent will have a capacity greater than or equal to 170,000 centimeters. As these larger, more efficient new builds hit the water, some older vessels with less capacity will likely be retired. Currently, all of these LNGCs operate (or intend to operate) under a foreign (non-U.S.) flag with foreign crews and must have a Certificate of Compliance examination from the USCG when operating in U.S. waters to verify compliance with international safety standards and U.S. regulations. These ships are required to have an operations plan written in English and at least one officer aboard at all times who is fluent in English and is knowledgeable of the cargo systems (USCG and MARAD 2003).

5.3.4.3 Floating Liquefied Natural Gas Vessels

The proposed project would have four FLNGVs. Each FLNGV would be fitted with Mark III membrane type LNG storage tanks in a double-row configuration as a cargo containment system. In the nominal design case, each of the four FLNGVs would process approximately 500 million standard cubic feet per day (MMscfd), which would total 2.0 billion standard cubic feet per day (Bscf/d) of input feed gas for all four of the FLNGV. Based on an estimated availability of 92 percent and allowance for consumption of feed gas during the liquefaction process, each FLNGV would normally produce approximately 3.0 million metric tonnes per annum [MMtpa]) for export in the form of LNG. Together, in the nominal design case, the four FLNGV are designed to have the capability to export approximately 12.0 MMtpa in the form of LNG. The natural gas would be liquefied and stored on the FLNGV until delivered to LNGCs via ship-to-ship transfer through cryogenic hoses or loading arms.

The LNG storage capacity of each FLNGV is approximately 210,000 m^3. Each vessel shall have eight LNG tanks.

Unlike LNGCs, there are currently no FLNGVs so there is no safety experience to draw from to assess the impacts on public safety and property. The properties of LNG, the materials and design of tanks and piping systems, however, are very similar to LNGCs so it is reasonable to use the same studies cited for LNGCs.

5.3.4.4 Port Security

If approved, the Applicant would be required, as part of the Deepwater Port Operations Manual, to submit a Deepwater Port Security Plan (DWPSP) (33 Code of Federal Regulations [CFR] 150.15(x)). The purpose of the DWPSP is to provide the Applicant's personnel who have security response responsibilities with a systematic approach to securing the deepwater port, and protecting personnel working at the proposed Project from human-caused threats such as theft, vandalism, or terrorism. The DWPSP would be included as an integrated component of the Deepwater Port Operations Manual.

After the events of September 11, 2001, the USCG reaffirmed its Maritime Homeland Security mission and its lead role, in coordination with other Federal, State, and local agencies; owners and operators of vessels and marine facilities; and other entities with interests in the U.S. Marine Transportation System, to detect, deter, disrupt, and respond to attacks by terrorist organizations against U.S. territory, population, vessels, facilities, and critical maritime infrastructure. In December 2002, at the urging of the USCG, the United Nation's IMO Maritime Safety Committee developed amendments to the 1974 International Convention for Safety of Life at Sea (SOLAS) intended to enhance maritime security. The new International Ship and Port Facility Security (ISPS) Code was also adopted to provide a standardized, consistent framework for evaluating risk, enabling governments to offset changes in threat with changes in vulnerability for ship and port facilities. The implementation schedule of both the SOLAS amendments and the ISPS Code was July 1, 2004.

On a national front, the U.S. Congress enacted the Maritime Transportation Security Act (MTSA) in November 2002, which was designed to protect U.S. ports and waterways from a terrorist attack by requiring area maritime security committees and security plans for facilities and vessels that might be involved in a transportation security incident.

Accordingly, the USCG developed maritime security rules (33 CFR Subchapter H – Maritime Security) that require owners and operators of certain facilities in U.S. ports, and certain vessels operating in U.S. waters, to conduct a Facility/Vessel Security Assessment (FSA), name a Facility/Vessel Security Officer (FSO), and develop and implement a Facility/Vessel Security Plan (FSP). If a License is issued, the USCG would require that Delfin LNG develop assessments and plans to ensure consistency with MTSA requirements for the proposed Project facilities, the FLNGVs, and the LNGCs.

In addition to the general risk prevention and minimization strategies discussed below, detailed prevention and mitigation strategies for both accidental and intentional release scenarios would be developed in a coordinated effort between USCG (CG-OES-2 and the Sector), local law enforcement officials, and the Applicant in the Deepwater Port Operations Manual and FSP, if the application is approved and MARAD issues a license. Process design and operational reviews and approvals also would increase safety by further preventing or minimizing potential risks. Although ongoing, much of this activity is completed in the post-licensing phase of the application.

Safety and security criteria for vessel and port operations were used in evaluating the proposed Port's location and would be critical components of the Port's design and operating procedures. For approval by USCG, the offshore location for the proposed Port must be conducive to safety by minimizing any potential risks while simultaneously allowing for adequate security. The proposed Port would be approximately 40 nautical miles from shore, and there are several existing offshore structures proximal to this location.

Federal regulations require all LNG vessels to provide a 96-hour advanced notice of arrival to the USCG prior to entering any U.S. port. Information about the vessel and its voyage, including its port of origin, cargo on board, crew members, passengers, status of essential equipment, and special security information, must be provided with the notice of arrival. All persons would be screened by the National Vessel Movement Center prior to the vessel's entry. Complete details concerning the USCG's notice of arrival requirements can be found in 33 CFR 160.

The USCG may routinely complete facility inspections, shipboard safety and security examinations, vessel escorts, and cargo monitors while a vessel is in U.S. waters or at a facility discharging its LNG cargo. A detailed Emergency Response Plan would be part of the Deepwater Port Operations Manual and DWPSP that would require the approval of the USCG during the post-licensing phase prior to beginning of operations, if the MARAD license is issued.

Under the MSTA of 2002 and ISPS regulations, shipping companies, vessels, and facilities are required to have a security officer and a comprehensive security plan to conduct their operations. Delfin LNG would be required to develop a DWPSP, approved by the USCG in accordance with Federal regulations.

Similarly, LNGCs would have a vessel security officer onboard to oversee security measures. A vessel security plan would be required as well. This plan would necessitate USCG review and approval prior to entry into the Port and would integrate with the overall DWPSP when the vessel is moored. Both the proposed facility and the vessel would require specific and detailed contingency procedures to be developed within their security plans. Implementation of these procedures would be required to enhance safety and security; and to protect the vessels, their cargo, and the marine environment.

This plan would address security issues including, but not limited to, access control for people, goods and material; monitoring and alerting vessels that approach or enter the proposed Port Safety Zone and security zone (if administratively and non-regulatorily established by the DWPSP); identifying risks and measures to deter terrorist activity; internal and external notification requirements and response in the event of a perceived threat or attack on the proposed Project; designating a port security officer; providing identification means for personnel; security training requirements; actions and procedures that are scalable to the threat; emergency procedures such as evacuation; special operations procedures; and recordkeeping for periodic training, drills, and exercises. Additional requirements for the security plan include, but are not limited to, radar monitoring of the Safety Zone and any non-enforceable, self-monitored zones for situational awareness of vessel traffic in the general vicinity, that the proposed Port may incorporate into the DWPSP, maritime security levels, ship security plans, ship security alarm systems, AIS, and declarations of security between the proposed Port facilities and visiting vessels.

The USCG has a number of measures available to enforce security requirements and otherwise enhance security for vessels and port facilities in the United States. These measures include conducting random and targeted patrols and vessel boardings; reviewing information contained in vessel arrival notifications; conducting escorts and targeted boardings of vessels identified as high risk; conducting background intelligence checks; reviewing, approving and exercising vessel and facility security plans; and other appropriate actions designed to improve maritime security.

The Applicant would work with local USCG units to ensure the proposed Port meets the requirements of the USCG Maritime Security and Response Operations Manual and the port security procedures are integrated and coordinated with the local USCG units.

5.4 LNG Spill Consequence Analysis

As stated above, Risknology was tasked by Delfin LNG to perform an LNG spill consequence analysis to support the Delfin LNG Deepwater Port License Application process (see Appendix Q).

The information, figures, and tables that follow present the hazard zone distances as a circle around the deepwater port release source to represent the maximum vapor cloud dispersion distance scenario in all metocean conditions. In reality, not all portions of the circle would be impacted by a release. Site- and time-specific winds and currents would direct the release in a more limited and focused directional quadrant from the source. Near the origin of the spill, the shape of the vapor cloud is wider, dominated by heavy gas effects, and farther downwind the cloud transitions to a more classical dispersion profile, tapering off at the maximum LFL distance.

The following lengths and distances are assumed:

- TYMS to FLNGV: 60 m
- FLNGV length: 356 m
- TYMS to stern of FLNGV (60 + 356 m): 456 m (0.22 nautical mile)
- Stern of FLNGV #2 oriented southwest, nearest to Sabine Pass Safety Fairway: 2.91 nautical miles

Based on the above, the Sabine Pass Safety Fairway is:

- 3.13 nautical miles from the TYMS of FLNGV #2, and
- 2.91 nautical miles from the stern of FLNGV #2 with stern of vessel at closest point.

The Risknology Spill Consequence Analysis modeling used 3.13 nautical miles as the distance to Sabine Pass Safety Fairway.

5.4.1 Purpose and Objectives

The purpose of the Delfin LNG Project spill consequence analysis prepared by Risknology was to present the consequence analysis of flammable vapor clouds dispersion distances and thermal radiation distances from potential pool fires and hazards resulting from LNG spills on water, based on guidelines published by Sandia (Sandia 2004, 2008; DOE 2012).

Sandia describes separate “zones” of risk to consider when evaluating risk reduction strategies for accidental and intentional spills of LNG; these zones are based not only on the thermal radiation and vapor dispersion effects described earlier but also site characterization. Thermal radiation and vapor dispersion hazard distances on open water in the vicinity of the proposed Port were determined through large-scale LNG spill modeling. These hazard distances would need to be considered by any operations or structures that may occur or be installed within the vicinity of the proposed Port.

- **Zone 1.** From ship to 11,900 Btu/hr/ft^2 (37.5 kW/m^2): In this area, the risk and consequences of a large LNG spill could be significant and result in severe negative impacts. Severe structural damage, including steel structures and immediate fatalities.
- **Zone 2.** Between 37.5 kW/m^2 and 5 kW/m^2: The consequences of a large LNG spill are of varying damage. Options for structure and personnel protection required or negatively impacted.
- **Zone 3.** Less than 5 kW/m^2: Area where only minor impact on personnel would occur provided they move away from the fire.

In addition, thermal effects from a potential vapor cloud fire must be considered as well as the health hazards of the vapor itself beyond the LFL. Because the proposed Project’s location is at least 40 nautical miles offshore of any population or commercial centers, the proposed Project would have minimal potential risk to public safety and property.

5.4.2 Technical Approach

The methodology followed by Risknology was as follows:

- **Project Description:** Site-specific information was presented, including weather information and location of neighboring platforms and shipping fairways. In addition, a general description of the FLNGV was included, with emphasis on the LNG storage system.

- **Scenario Development:** An overview of the scenarios that were evaluated for the consequence analysis was developed, and discussion was made of the assumptions that were considered for the modeling of each scenario, as well as the sequence of events derived from the loss of containment from the FLNGV.
- **Modeling Results:** Results were calculated from the different spill scenarios, considering two possible types of breaches (accidental or intentional).
- **Comparison to Sandia Results:** The scenario results calculated in the previous sections were then compared with those documented in Sandia's reports.

5.4.3 Deepwater Port Potential Impact

The Risknology report evaluated the thermal radiation and flammable vapor cloud dispersion for accidental and intentional release scenarios and used this evaluation to define hazard zones. The hazard zones have been presented as graphical overlays on the nautical charts for the proposed Project location. The results of the study are presented without passing judgment on the merits of the Applicant's proposed Project (see Appendix Q).

While the study evaluated the potential impacts on the public and surrounding infrastructure, it did not attempt to predict the number of estimated fatalities or injuries from these events or any mitigation measures that could be implemented to reduce the risk of accidental or intentional release of LNG from this proposed Project. Mitigation measures to reduce the risk associated with an LNG release caused by both accidental and intentional scenarios will be proposed and evaluated in a coordinated effort with the Applicant, in consultation with the USCG and local stakeholders, and included in the Deepwater Port Operations Manual. For maritime security reasons, this information will not be made public.

5.4.3.1 LNG Release Scenarios

The analysis considered two possible types of breaches—accidental or intentional—involving one to three LNG cargo tanks. The LNG spill resulting from any of these events would form a pool of LNG on the water surface, which can cause a pool fire or form a dense flammable vapor cloud that will disperse downwind until it is diluted by air if it does not ignite and burn.

The USCG has not included a detailed offshore vessel traffic management and collision analysis in this final EIS. Sandia National Labs, as noted in its 2004 and 2008 LNG reports, identified accidental and intentional threat scenarios that could include breaching of more than one LNG cargo tank during intentional events; these types of multiple events have been considered and the impact of the hazard results are discussed in this chapter. Damage to an adjacent LNG cargo tank from the initial damage to one LNG cargo tank could be possible, based on current experimental data and modeling evaluations, and has been considered in our analyses. As discussed in the 2004 Sandia LNG report, multiple tank spills are not considered the most likely or nominal LNG spill event, but should be a consideration in developing risk management and mitigation approaches to LNG spills and associated hazards. Consideration of up to three tanks spilling at any one time is expected to provide a conservative analysis of possible multi-tank damage concerns and associated hazards; therefore, the final EIS uses a three-tank breach as its bounding limit for a worst-case discharge, which includes a vessel collision resulting in an LNG spill at the port. The Delfin LNG deepwater port is proposed to be located in USCG Captain of the Port (COTP) Port Arthur's area of responsibility. A COTP's responsibility includes enforcement of port safety and security and marine environmental enforcement regulations, including regulations for the protection and security of deepwater ports (see 33 CFR 1.01-30). To the extent a hazardous condition exists at or adjacent to a deepwater port, the COTP may implement appropriate corrective action.

Accidental Scenarios Results

Similar to the vapor dispersion analysis, the hazard distances for pool fires from an accidental breach of LNG tanks were calculated using the Process Hazard Analysis Software Tool (PHAST) for the following scenarios:

- accidental event leading to a 1 m^2 hole in a single tank of FLNGV, and
- accidental event leading to a 2 m^2 hole in a single tank of FLNGV.

The results from these events are summarized in Table 5.4-1 for heat radiation levels.

Table 5.4-1. Distances to Flux Radiation Levels for Accidental Scenarios

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Surface Emissive Power (kW/m^2)	Pool Radius (m)	Distance in (m)		
					To 5 kW/m^2	To 12.5 kW/m^2	To 37.5 kW/m^2
1	1	0.6	220	103.8	870	604	331
2 a/	1	0.6	220	148.3	1136	789	434

Note:
a/ the nominal scenario
Key: kW/m^2 = kilowatts per square meter

Intentional Scenarios Results

The hazard distances for pool fires from an intentional breach of LNG tanks were calculated using Phast for the following scenarios:

- intentional event leading to a 5 m^2 breach in a single tank of FLNGV (nominal case, Sandia 2004);
- intentional event leading to a 12 m^2 breach in a single tank of FLNGV (nominal case, Sandia 2008);
- intentional event leading to a 16 m^2 breach in a single tank of FLNGV;
- intentional event leading to a 5 m^2 breach in three tanks of FLNGV; and
- intentional event leading to a 12 m^2 breach in three tanks of FLNGV.

The results from these events are summarized in Table 5.4-2 for heat radiation levels.

Table 5.4-2. Distances to Flux Radiation Levels for Intentional Scenarios

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Surface Emissive Power (kW/m^2)	Pool Radius (m)	Distance in (m)		
					To 5 kW/m^2	To 12.5 kW/m^2	To 37.5 kW/m^2
5	1	0.6	220	235.7	1,576	1,034	529
12 a/	1	0.6	220	366.8	2,200	1,451	753
16	1	0.6	220	365.6	2,194	1,447	751
5	3	0.6	220	410.5	2,394	1,581	825
12	3	0.6	220	552.5	2,991	1,985	1048

Note:
a/ the nominal scenario
Key: kW/m^2 = kilowatts per square meter

Figure 5.4-1 shows the 5 kW/m^2 heat flux contour for the intentional breach case as defined by Sandia in 2004 and 2008. The 5 kW/m^2 heat flux contour is a maximum heat flux value commonly used for establishing fire protection distances for people in open areas.

The largest intentional breach would be one corresponding to a spill from a 12 m^2 breach in three tanks, as shown in Figure 5.4-2. It should be noted that this is not considered a nominal (most likely) case even for intentional events, and this scenario is evaluated only to provide a conservative estimation of possible cascading damage concerns.

None of the pool fire hazard scenarios evaluated reached another FLNGV, neighboring platform, or the shipping fairway, therefore, the analysis suggests that there would be a minimal impact on public safety from even a large spill from the FLNGVs.

Additional Spill Consequence Analysis

Following publication of the draft EIS and by recommendation of Sandia National Laboratory, Delfin LNG had Risknology perform additional thermal radiation modeling for LNG releases and pool fire scenarios assuming a higher wind speed of 10 m/sec, temperature of 17 degrees C, and relative humidity of 44 percent that would result in larger thermal radiation contours. Table 5.4-3 presents a combination of previously provided results and supplemental calculated values associated with the seven pool fire scenarios for the project which are defined in Reference 1 of the report (Appendix Q).

Though these atmospheric conditions increase pool fire thermal radiation distances approximately 400 meters or 14 percent, the consequences remain the same as noted above in not reaching another FLNGV, neighboring platforms, or the shipping fairway.

Table 5.4-3. Calculated Quantities for Pool Fire Scenarios

Hole Size (m^2)	Tanks Breached	Rate in (kg/sec)		Spill Mass (kg)	Duration in (sec)		Pool Diameter (m)	Flame Angle (deg.)	Distance in (m)		
		Max Vapor.	Ave. Burn		Spill	Burn			To 5 kW/m^2	To 12.5 kW/m^2	To 37.5 kW/m^2
1	1	4,220	11,940	1E+07	2,461	878	207	46.0	943	664	424
2	1	10,792	24,346	1E+07	1,230	431	295	43.8	1,239	872	553
5	1	53,295	61,511	1E+07	428	170	470	40.9	1,775	1,251	788
12	1	79,461	149,016	1E+07	205	70	732	38.1	2,491	1,761	1,102
16	1	77,332	148,015	1E+07	154	71	730	38.1	2,486	1,757	1,100
5	3	44,478	186,577	2.6E+07	492	138	819	37.4	2,715	1,920	1,200
12	3	79,491	338,071	2.6E+07	205	76	1,105	35.4	3,409	2,417	1,507

Key:
m = meters; m^2 = square meters; deg. = degrees; kW/m^2 = kilowatts per square meter; sec = second; kg/sec = kilograms per second

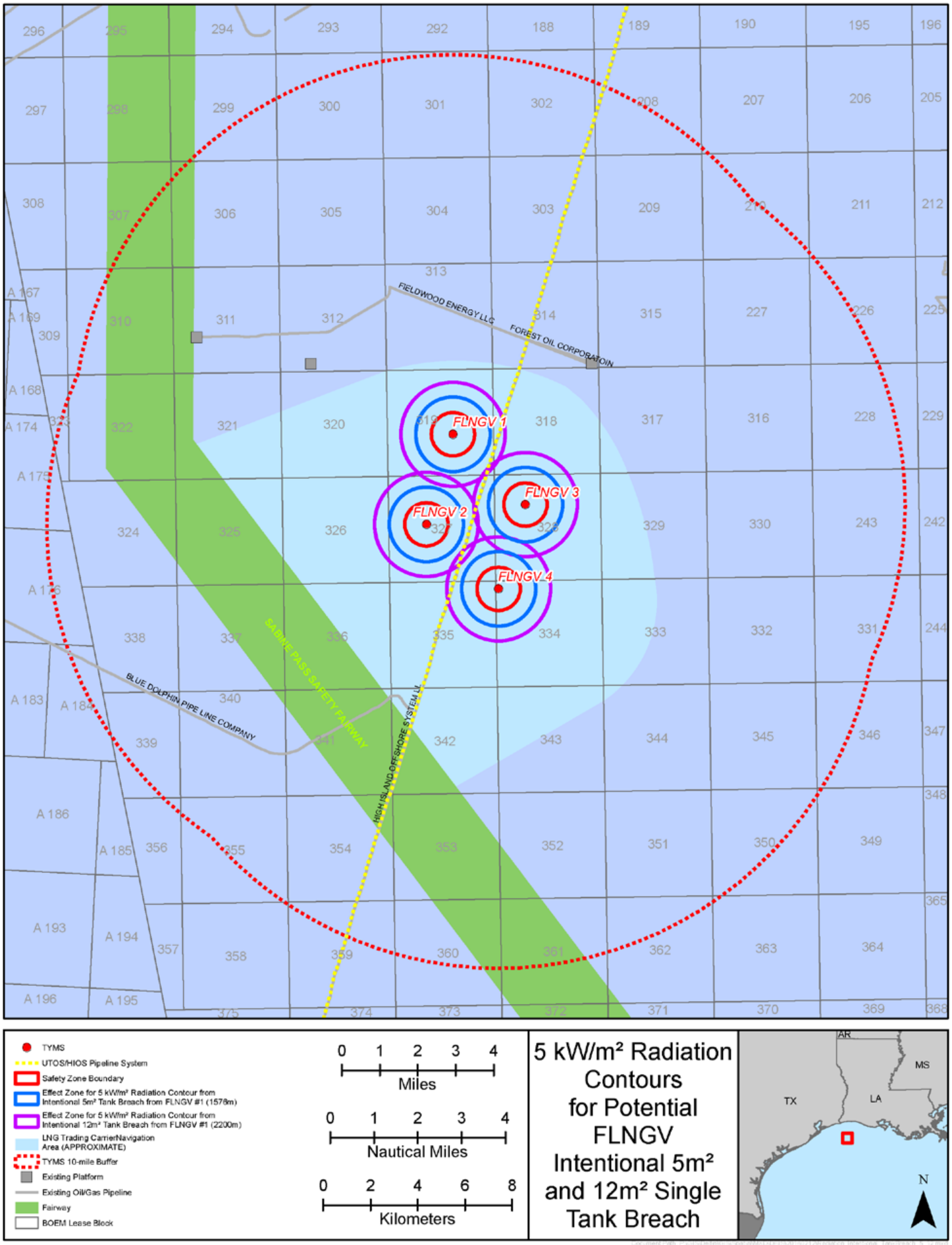

Figure 5.4-1. **5 kW/m² Radiation Contours for Potential FLNGV Intentional 5 m² and 12 m² Single Tank Breach**

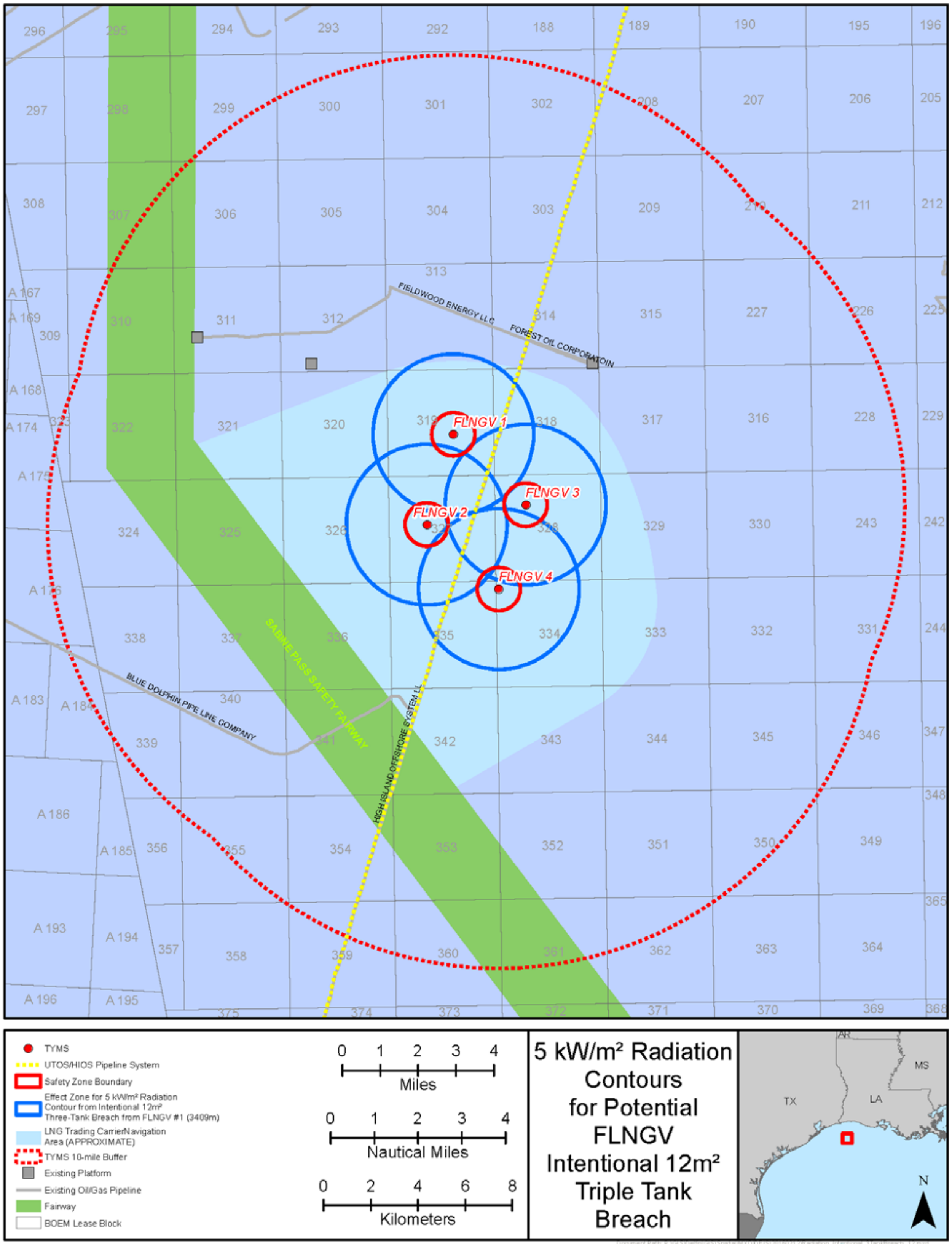

Figure 5.4-2. **5 kW/m² Radiation Contours for Potential FLNGV Intentional 12 m² Triple Tank Breach**

5.4.3.2 Flammable Vapor Cloud Dispersion

Accidental Scenarios Results

The vapor dispersion zones from an accidental breach of LNG tanks were calculated using PHAST dispersion modeling for the following scenarios:

- accidental event leading to a 1 m^2 hole size in a single tank of FLNGV, and
- accidental event leading to a 2 m^2 hole size in a single tank of FLNGV.

The results from these events are summarized in Table 5.4-4 for LFL maximum distances. Figure 5.4-3 portrays the distance surrounding the FLNGV locations for the 2 m^2 accidental breach.

Table 5.4-4. LFL Distances for 1 and 2 m^2 Single Tank Accidental Hole Breach

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Distance to LFL (m)
1	1	0.6	1,792
2 a/	1	0.6	2,297

Note:
a/ the nominal scenario
Key:
m^2 = square meters; LFL = lower flammability level

Intentional Scenarios Results

The vapor dispersion zones from an intentional breach of an LNG tank were calculated using the three breach sizes listed in Table 5.4-5, and the effect zones for the single tank 5 m^2 and 12 m^2 holes is shown in Figure 5.4-4.

Table 5.4-5. LFL Distances for intentional Breach Events by Hole Size (m^2)

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Distance to LFL 55000 ppm (m)
5	1	0.6	3,917
12	1	0.6	5,368
16	1	0.6	5,334

Key:
m^2 = square meters; LFL = lower flammability level; ppm = part per million

The LFL distances from an intentional breach of three LNG tanks were calculated using the two breach sizes listed in Table 5.4-6, and the effect zone for the cascading breach of three tanks with a 12 m^2 hole is shown in Figure 5.4-5

Table 5.4-6. LFL Distances from Intentional Three-Tank Cascading Breach

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Distance to LFL 55000 ppm (m)
5	3	0.6	5,615
12	3	0.6	6,575

Key:
m^2 = square meters; LFL = lower flammability level; ppm = part per million

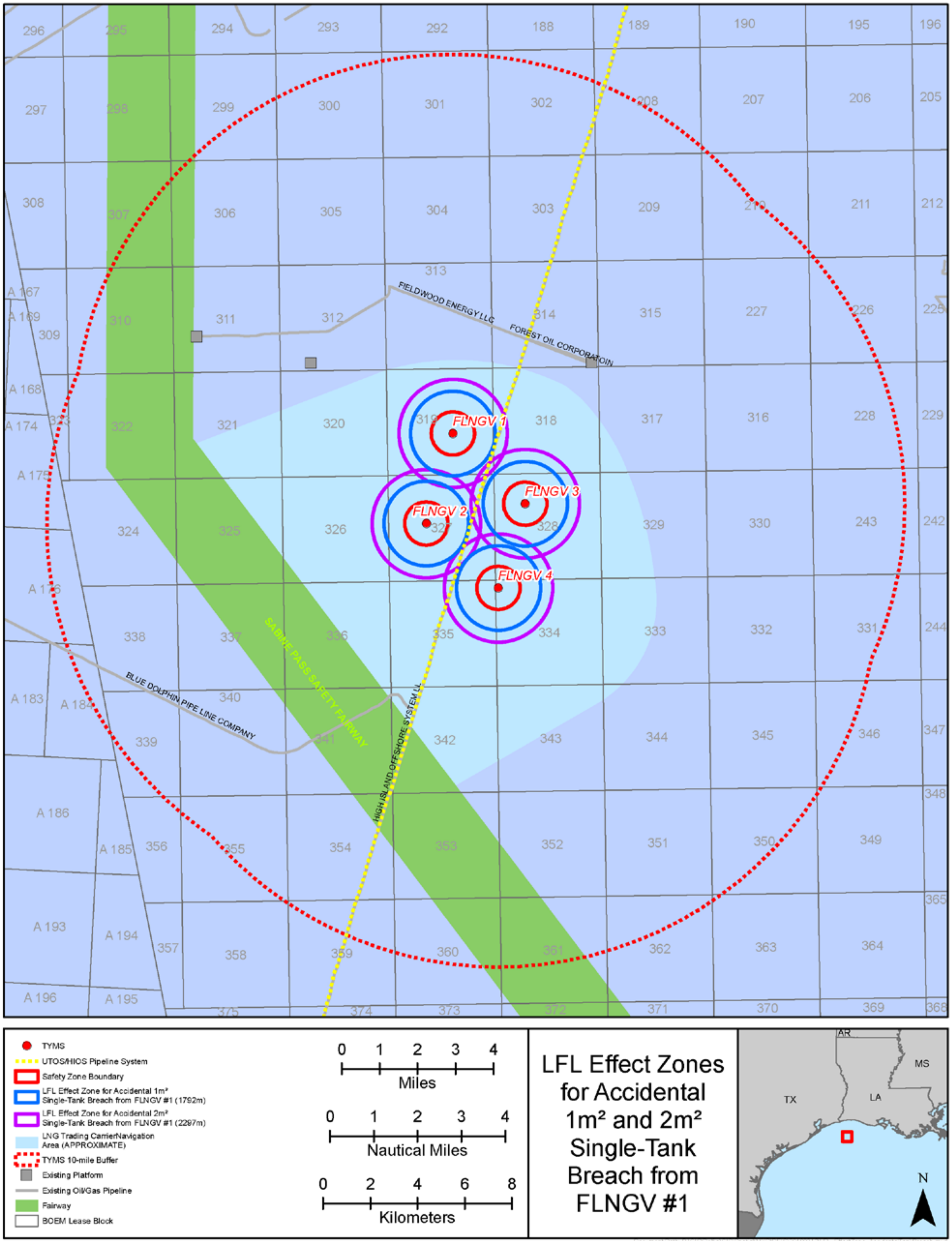

Figure 5.4-3. **LFL Effect Zones for Accidental 1 m^2 and 2 m^2 Single-Tank Breach from FLNGV #1**

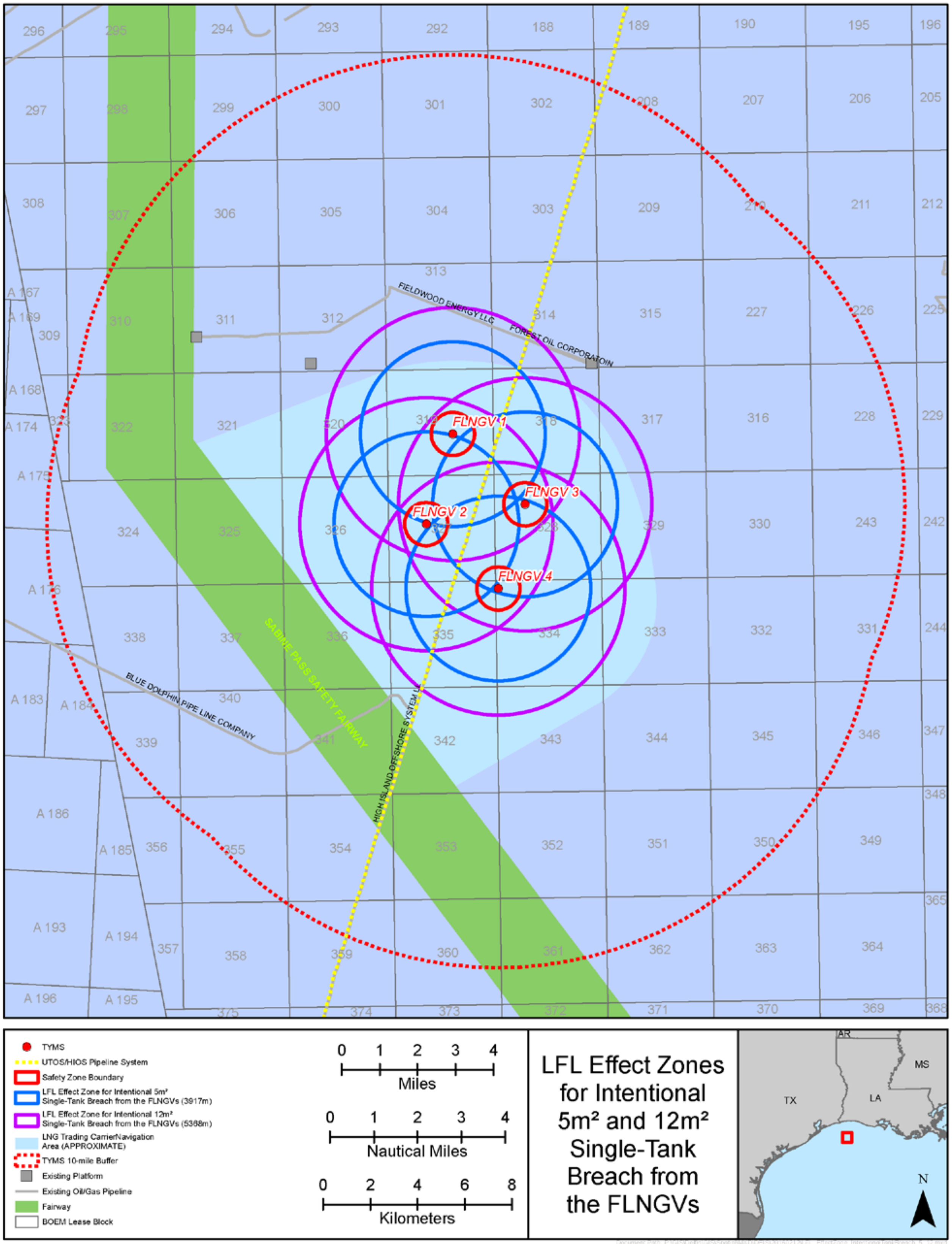

Figure 5.4-4. LFL Effect Zones for Intentional 5 m² and 12 m² Single-Tank Breach from the FLNGVs

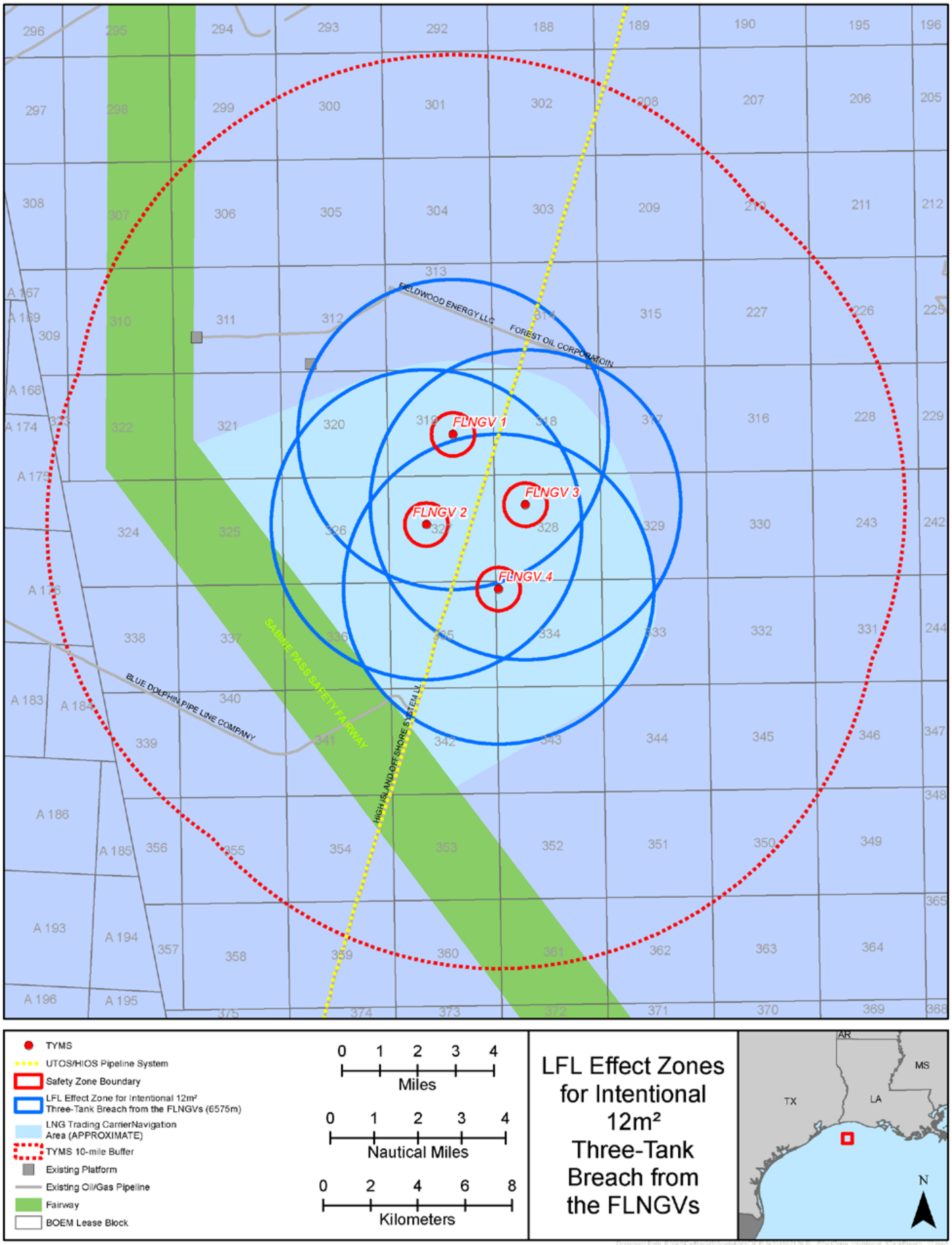

Figure 5.4-5. LFL Effect Zones for Intentional 12 m^2 Three-Tank Breach from the FLNGVs

The flux radiation distances from an intentional three-tank cascading breach are shown in Table 5.4-7.

Table 5.4-7. Flux Radiation Distances from Intentional Three-Tank Cascading Breach

Hole Size (m^2)	Tanks Breached	Discharge Coefficient	Surface Emissive Power (kW/m^2)	Distance in (m)		
				To 5 kW/m^2	To 12.5 kW/m^2	To 37.5 kW/m^2
5	3	0.6	220	2,394	1,581	825
12	3	0.6	220	2,991	1,985	1,048

Key:
m^2 = square meters; kW/m^2 = kilowatts per square meter

The effect zone for the cascading breach of three tanks with a 12 m^2 hole is shown in Figure 5.4-2.

5.4.3.3 Summary of Risknology Findings

As shown in Table 5.4-8, calculated intentional event hazard distances were greater than those generated by accidental releases.

Table 5.4-8. Hazard Distances, Using Nominal Case Breach Events

Hazard Type	Exposure Level	Accidental Event	Intentional Event
Vapor Cloud Dispersion			
Distance to lower flammability limit (meters)	5.5%	2,297	5,368
Pool Fire			
Distance to “Low” Radiative Flux (meters)	5 kW/m^2	1,136	2,200
Distance to “High” Radiative Flux (meters)	37.5 kW/m^2	434	753

Based on the results of this nominal case breach study, flux radiation levels generating from a pool fire would not reach other FLNGVs, platforms, or the shipping fairway for all breaches considered. The Deepwater Port Application process should consider hazard exclusion zones of, at minimum, 753 m and 2,200 m for high and low thermal radiation levels.

The vapor dispersion distance to the LFL using 5.5 percent concentration for the 12 m^2 breach of a single tank resulting from an intentional event is approximately 5,368 m. This has the potential to affect other FLNGVs, depending on multiple weather parameters such as wind speed and wind direction, but would not reach other platforms located within 10 miles from the FLNGVs or the shipping fairway. This conclusion should be considered in the context that the scenario is a very low probability event given:

- the fact that a large release of LNG is likely to be accompanied by an ignition source and result in a fire rather than dispersion of natural gas vapors over extended distances;
- that if delayed ignition did occur at the location of encounter of an adjacent FLNGV, the flame front would burn back to its source and away from the neighboring facility; and
- the exposure time of the neighboring facility to the flash fire thermal radiation would be insufficient to cause process escalation.

5.4.3.4 Worst Credible Release Scenarios

The worst credible release scenario, although actually considered highly unlikely, was assumed to be a cascading event of a 12 m^2 three-tank breach to provide a conservative estimate. A breach size of up to 12 m^2 was modeled (see Table 5.4-9 for summary results). The LNG spill resulting from such an event would form a pool of LNG on the water surface, which can cause a pool fire or form a dense flammable vapor cloud that would disperse downwind until it is diluted by air. Though a three-tank cascading event has an extremely low probability, if it should occur and also given the meteorological conditions, the modeling shows that the 6,575-m vapor dispersion cloud from FLNGV #2 and possibly FLNGV #4 could impact the Sabine Pass Safety Fairway. It should also be noted that each FLNGV location could impact another and the 5 kW/m^2 flux radiation level could approach the safety zone of another FLNGV location.

Table 5.4-9. Worst Credible Release Hazard Distances to 12 m^2 Three-Tank Cascading Breach Events

Hazard Type	Distances (meters)	Updated Distances (meters)
Flux Radiation Levels		
5 kW/m^2	2,991	3,409
12.5 kW/m^2	1,985	2,417
37.5 kW/m^2	1,048	1,507
Lower Flammability Limit (LFL)		
Distance to LFL 55,000 ppm (m)	6,575	NA
kW/m^2 = kilowatt per square meter; ppm = part per million; m = meter		

The 2,991 m flux radiation and 6,575 m LFL hazard exclusion zones for this worst credible release scenario, along with appropriate additional standoff distance, rather than the previously addressed nominal cases would need to be considered in the port emergency response planning and Deepwater Port Operations Manual should the proposed Port be approved and licensed.

While the LNG release consequence modeling report includes estimates of the thermal radiation and vapor dispersion distances for a three-tank simultaneous release, the probability of this is occurring is extremely remote. Most scenarios involving a major release of LNG are likely to result in a pool fire due to ignition caused by the initiating event (collision, explosion, etc.) or natural gas vapor migration to another available ignition source. Nonetheless, even the remote, three-tank, unignited LNG release event does not result in any risk to the general public on shore, or any nearby non-Delfin Project facilities. If the port is approved, mitigation measures must still be included in the Deepwater Port Operations Manual to reduce the risk of impacting shipping traffic in the Sabine Pass Safety Fairway.

Delfin LNG has committed to working with local USCG units to develop a communications plan that would alert marine traffic and other maritime activities in the area of a LNG release to avoid and or evacuate the area. A cascading release of this magnitude would actually allow time for this prior to reaching the Fairway shipping traffic. This would be similar to current procedures in place for onshore LNG terminals in proximity to shipping channels.

5.5 Marine Safety

Marine safety for vessels, deepwater ports, and offshore structures is regulated through a framework of overlapping international treaties and standards; national laws and regulations; and Federal and State port or area-specific rules. The agency with primary responsibility for vessels and deepwater ports in the proposed area is the USCG. The USCG currently boards foreign-flagged vessels under the Port State Control program, and may board, inspect, and search any vessel entering a U.S. port. The USCG is also charged with a lead role in all aspects of application and approval of deepwater ports; reviewing and approving operations and security plans; and periodic inspection of the facilities (once constructed) to enforce compliance with environmental, safety, and security requirements.

5.5.1 Marine Safety Standards

In accordance with 33 CFR 150, the licensee of the deepwater port could not operate the proposed Port without prior USCG approval of the Deepwater Port Operations Manual. If the MARAD License is granted to the Port Operator, it would require that the Operations Manual address the requirements of the

DWPA and provide detailed specifications and procedures for all aspects of Port operations and infrastructure. The Operations Manual would address security, emergency response, public and personal safety, protection of the environment, navigation, vessel movement, materials handling, and personnel qualifications. The Operations Manual would be required to address Port requirements for calling vessels, approaches, Safety Zone, port infrastructure, and pipelines.

If the proposed Project is approved and commences operations, the USCG would conduct regular inspections to ensure that the Deepwater Port Operations Manual is being properly implemented. In addition, the USCG would review the Operations Manual from time to time, and propose or require amendments as necessary to meet the intentions of the appropriate regulations and address potential changes in conditions.

Marine safety would be enhanced, in part, by navigation aid systems, fire and gas detection systems, emergency shutdown systems, and communication systems.

In addition, during the construction phase of the proposed Port, the USCG would be responsible for approval and oversight of design, fabrication, installation and construction, and commissioning. Any substantive changes that would affect the Deepwater Port Operations Manual and equipment would also have to be reviewed and approved. The USCG would also coordinate with the PHMSA as the technical and approval authority of pipeline design, construction, operations, and maintenance.

5.5.1.1 Navigation Aid Systems

The USCG has requirements for indicating the location of fixed structures on nautical charts, and the USCG 8th District's Local Notice to Mariners (LNMs; monthly editions and weekly supplements) informs local mariners about locations of aids to navigation. Additionally, Marine Safety Information Broadcasts (MSIBs) would be issued whenever Port-related activities (e.g., construction, marine mammal monitoring or general Port operations) are occurring.

The FLNGVs and LNGCs would be equipped with all appropriate navigation lighting aid systems required for moored or berthed vessels. The proper day signals or navigation lights would be visible during the appropriate times of day and would comply with the 1972 International Rules of the Road (72 COLREGS) requirements. The 72 COLREGS govern the color, placement, range of visibility, and use of lights and shapes on all seagoing vessels and apply to all vessels operating on U.S. waters outside inland demarcation lines. At night, lighting would be appropriate for a vessel at anchor and conducting operations (deck lighting) for better visibility from passing vessels. AIS beacons would transmit the name and position of each FLNGV and each LNGC.

USCG District 8 Waterways Management and Aids to Navigation (ATON) will need to review proposed marking and lighting schemes if the application is approved. This port is proposed in a Class A area and must meet the requirements of 33 CFR 67.20 for Class A structure. The obstruction lights proposed for fixed structures are correct. The height requirement must be at least 20 ft above mean high water (MHW) but must be installed so the light is visible to the mariner regardless of angle of approach until within 50 ft of the structure (33 CFR 67.20-5). The fog horn proposed is an approved sound signal for a fixed Class A structure. The rotating beacon and characteristics are correct. The AIS must be approved by USCG Headquarters and the radar beacon (RACONS) may be approved by USCG District 8; however, the number of RACONS proposed is not in accordance with the ATON Admin Manual.

Marking determinations will normally be made following approval and issuance of the U.S. Army Corps of Engineers Permit if the port is approved.

5.5.1.2 Fire and Gas Detection System

The Applicant would be required to comply with applicable codes and standards for the FLNGV and LNGC safety systems and equipment onboard the vessels. These systems and equipment include detection, emergency shutdown, spill containment, fire protection, flooding control, crew escape and safety shelters, and all other such equipment as required by applicable Federal and international regulations and standards.

The International Gas Code (IGC) requires that each cargo tank be outfitted with an integrated instrumentation/alarm system that notifies the crew of possible leaks via gas detection and temperature sensors and tank liquid levels, temperatures, and pressures. These systems, as well as the pressure relief systems mentioned above, provide a many-layered protection against cargo release either through equipment malfunction or human error. Additional gas detection systems (integrated instrumentation/ alarm systems) are required by the IGC in spaces where cargo is located, including compressor spaces, spaces where fuel gas is located, and other spaces likely to contain gasified cargo. Venting systems for certain spaces and portable gas detectors are also required. Cargo loading areas and docks are also required by the IGC to be equipped with LNG vapor and fire detection systems that automatically shut down the transfer systems in the event of a leak or fire. Personnel on the FLNGV or LNGC can also manually operate these shutdowns.

5.5.1.3 Emergency Shutdown System

Emergency shutdown (ESD) is controlled by automatic or manually activated systems including automatic shutdown through the fire and gas detection or other systems on the FLNGV or LNGC requiring a total shutdown of transfer systems.

5.5.1.4 Communications System

The Applicant has stated that all moorings and departures by LNGCs to or from the proposed Port facilities would be carried out at the LNGC Master's discretion, as set forth in the Applicant's Deepwater Port Operations Manual. The dedicated support vessel would be within the proposed Area to be Avoided (ATBA) during all LNGC arrivals and departures. Prior to arrival or departure, the LNGC Master would make a broadcast via very high frequency (VHF) radio to warn any vessels in the area that the LNGC would soon arrive or depart.

As the LNGC prepares to arrive or exit the proposed Port facilities, the LNGC Master would evaluate weather conditions and determine the safest procedures and route for arriving or departing. The proposed Project facilities would not be made available to provide bunkers (fuel and diesel oil) or fresh water to moored LNGCs.

5.5.2 Navigational Safety Measures

The navigational safety measures within the Safety Zone, No Anchoring Areas (NAA), and the ATBA discussed below would be incorporated into Port operations with final dimensions and mandatory or recommendatory restrictions yet to be assessed for safety and security. It is likely, however, that the proposed dimensions would be a starting point for this assessment.

Under authority of the DWPA, 33 CFR 150 provides for NAAs and ATBAs that may be established in addition to a Safety Zone via a combined proposal by the Secretary of State and the USCG. There are other restrictions that may be established if needed to layer the safety measures and then bring the existing safety zones into IMO compliance.

5.5.2.1 Safety Zone

The DWPA requires the establishment of a zone of appropriate size around and including any deepwater port for the purpose of navigational safety. In such a zone, no installations, structures, or uses are permitted that would be incompatible with the operation of a deepwater port.

The USCG has promulgated regulations that provide requirements for the establishment of, restrictions, and location of safety zones, NAAs, and ATBAs around deepwater ports (33 CFR 150 Subpart J). Safety

Zone enforcement would fall under the Secretary of Homeland Security (i.e., the USCG as establishing agency).

If established, all unauthorized vessels would be prohibited from entering the proposed Safety Zone at any time. Delfin LNG proposes to monitor the Safety Zone and advise unauthorized vessels to avoid the restricted areas. Radar monitoring of the Safety Zone by Project personnel would be required when any vessel approached or entered this zone. Such vessels would be identified and warned off via radio or an assist vessel, if present at the port.

If approved and constructed, Port Delfin would be placed on nautical charts printed by the National Oceanic and Atmospheric Administration (NOAA) Office of Navigation and Charting. Included in the accompanying notes would be an explanation of the Safety Zone with references to the applicable Federal regulations and Coast Pilot for the geographic region.

The NOAA Office of Navigation and Charting reviews charts annually for updates and reprinting. In the interim, updates are distributed as monthly notices to mariners (NOAA) and weekly local notices to mariners (USCG). Commercial vessels regulated by the USCG must carry the latest version of paper charts, or at least currently corrected copies, and must be the appropriate scale for safe navigation in the areas transited. The NOAA website provides paper charts available for ordering electronic or "raster" charts available for downloading, and Coast Pilots[33] available for ordering or downloading. A fixed Safety Zone would surround each FLNGV and TYMS platform. If established, no vessel would be allowed to enter the Safety Zone except approved LNGCs and assist vessels.

Fishing and anchoring within the Safety Zones would be prohibited at all times. Appropriate Safety Zones would be defined and established by the USCG prior to commencement of Port operations. The proposed Delfin LNG Safety Zones would extend in all directions an additional 500 meters (m) beyond the limits established by the four FLNGV units allowed to weathervane in a complete circle. With the length of each FLNGV and the TYMS mooring structure added to the proposed 500-meter Safety Zone area, each of the four Safety Zone zones would have a radius of approximately 916 m (3,005 feet [ft]) as shown in Figure 5.5-1 and Figure 5.5-2.

[33] A series of nautical books that cover a variety of information important to navigators of coastal and intracoastal waters and the Great Lakes. Issued in nine volumes, they contain supplemental information that is difficult to portray on a nautical chart.

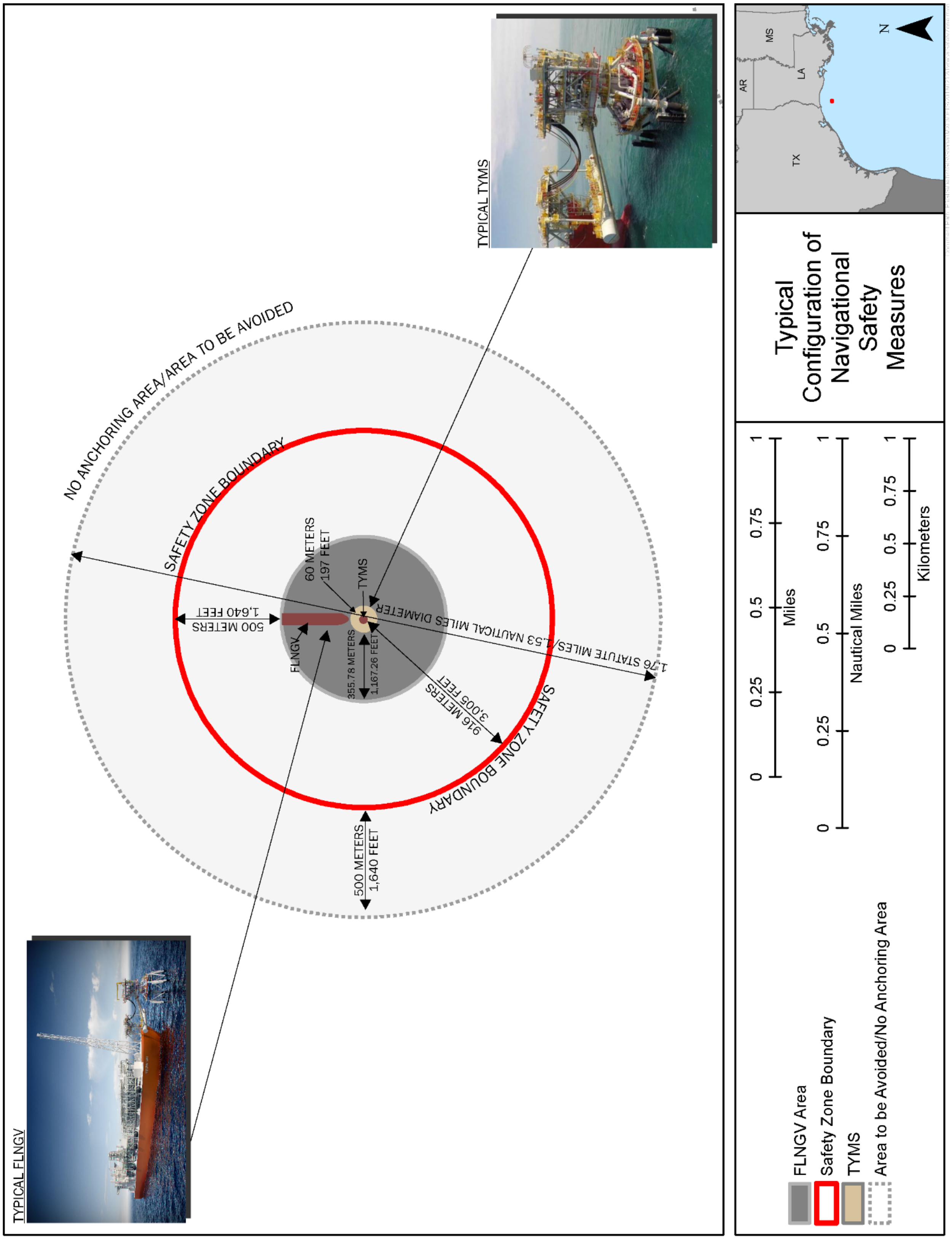

Figure 5.5-1. Typical Configuration of Navigational Safety Measures

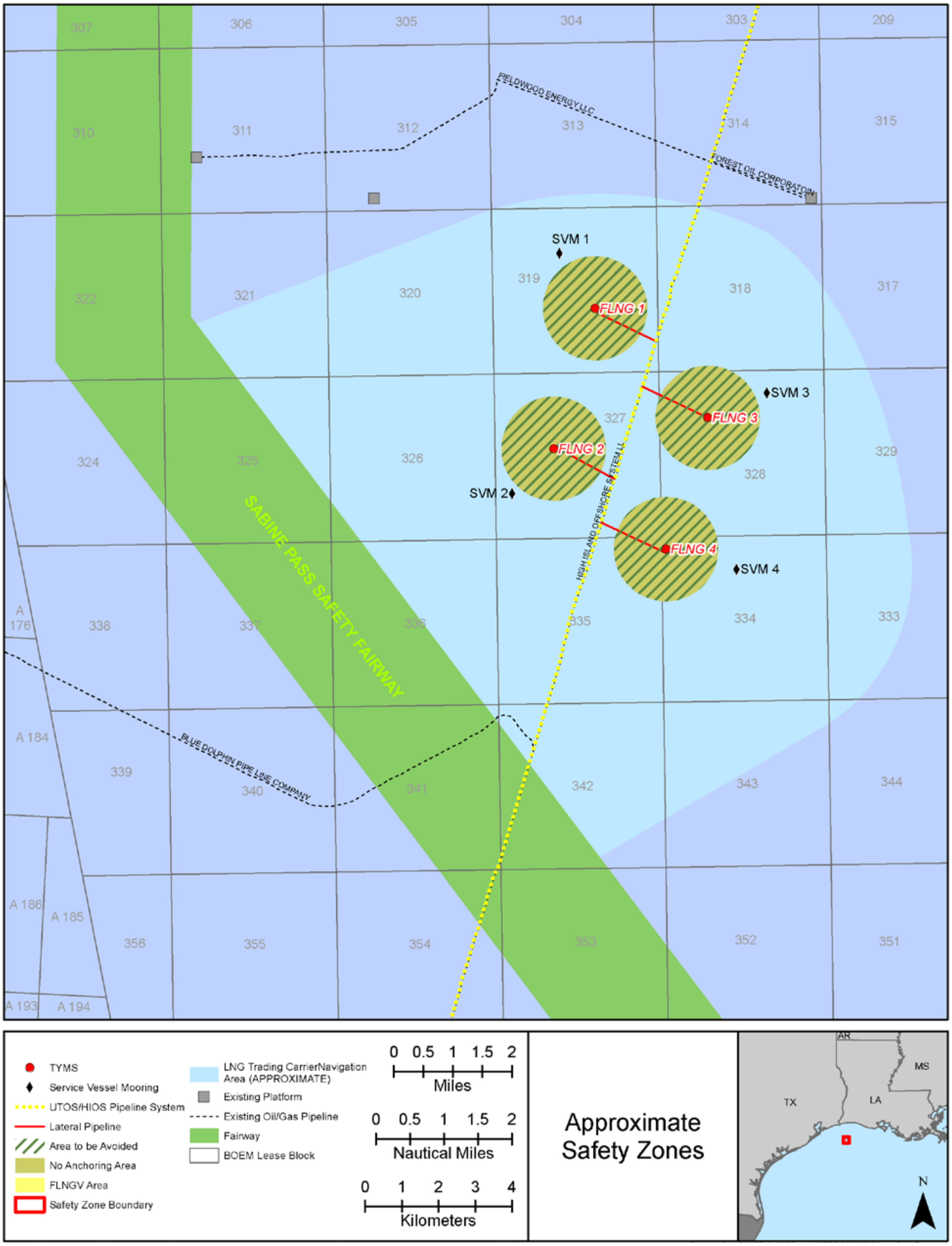

Figure 5.5-2. Approximate Safety Zone

5.5.2.2 No Anchoring Area and Area to be Avoided

In addition to the Safety Zone, NAAs and an ATBA are proposed to be established. As set forth by the Applicant, the proposed NAAs and ATBAs would have a radius of 0.8 nautical miles (1,416 m), measured from the center of each TYMS.

Both the NAAs and the ATBA would appear on subsequent editions of local and regional nautical charts. No vessels would be allowed to anchor in the NAAs. The restriction would likely also apply to bottom trawling. The ATBA is meant to discourage vessel traffic. It would help ensure that other vessels do not interfere with the deepwater port's operations, including the maneuvering of the LNGC and its support vessels. Both the NAAs and the ATBA are normally recommendatory. LNGC traffic would be coordinated by Delfin LNG personnel.

5.5.2.3 Designated Anchorage Areas

The Applicant has indicated that they do not intend to use designated anchorage areas in the event that LNGCs must delay their arrivals to the proposed Port facilities. Incoming LNGCs would instead vary their speed and course in order to arrive at the proposed Port facilities when conditions are clear.

5.5.3 LNG Vessel Support

The Applicant has stated that all moorings and departures by LNGCs to or from the proposed Port facilities would be carried out at the LNGC Master's discretion, as set forth in the Applicant's Deepwater Port Operations Manual. Dedicated support vessels would be within the proposed ATBA during all LNGC arrivals and departures. There would be no bunkering of LNGCs at the proposed Port facilities; thus, no vessels would be needed for that purpose.

5.5.3.1 Vessel Safety and Collision

While no site-specific ship collision analysis has been conducted (see Section 5.4.3.1), the Applicant selected the larger of the guidance cases as the dimensioning accidental release case.

If licensed, Delfin LNG would address navigational safety in the Deepwater Port Operations Manual. This would include coordination with the local USCG units on vessel routing measures around the proposed Port and Sabine Pass Safety Fairway as applicable to transiting LNGCs and support vessels.

BSEE requires that vessel collisions that are related to oil and gas exploration and production activities be reported to the agency (BSEE 2015). The BSEE defines a collision as the act of a moving vessel (including an aircraft) striking another vessel, or striking a stationary vessel or object (e.g., a boat striking a drilling rig or platform). All collisions that result in property or equipment damage greater than $25,000 must be reported (major collision). Collisions valued under $25,000 in damage are considered minor. Reports are included on most events that describe the circumstances surrounding the collisions (reports are not included for incidents that are still under investigation). These data show that from 2007 through 2014, there were 137 collisions reported in the Gulf of Mexico related to oil and gas exploration and production activities (see Table 5.5-1).

Mitigation measures to reduce the risk associated with an LNG release caused by both accidental and intentional scenarios will be proposed and evaluated in a coordinated effort with the Applicant, in consultation with the USCG and local stakeholders, and included in the Deepwater Port Operations Manual. For maritime security reasons, this information will not be made public.

Table 5.5-1. Gulf of Mexico Vessel Collisions 2007 to 2014

Collisions	2007	2008	2009	2010	2011	2012	2013	2014	2007-2014 Totals
Minor (under $25,000 damage)	8	8	7	1	2	1	7	5	–
Major (over $25,000 damage)	12	14	22	7	12	8	16	7	–
Collision Total per Year	**20**	**22**	**29**	**8**	**14**	**9**	**23**	**12**	**137**
Source: BSEE (2015)									

5.5.3.2 Mooring and Berthing

Approaching and departing LNGCs would be under the direction of an approved Delfin LNG pilot. Adequate tugboats would also be provided to assist LNGCs with arrival and departure. Specific requirements for pilots and tugs will be described in the Applicant's Deepwater Port Operations Manual. The embarked Delfin pilot, along with the LNGC's navigation crew, would maintain a visual lookout and would also use visual cues to assist in approaching and departing the FLNGVs. Minimum visibility standards for arrival and departure will be specified in the Operations Manual. The Operations Manual will also include specific environmental criteria for arrival and departure, including maximum winds speed, wave height, currents, or combinations of these conditions. Figure 5.5-3 shows several typical LNGC routes into and away from FLNGVs at the proposed Port. Actual routes would vary depending upon the prevailing environmental conditions.

5.5.3.3 Extreme Weather

The LNGCs would monitor current and forecasted weather conditions through regular monitoring of the vessel's equipment (such as radar, barometer, anemometer, and visual observation from the bridge) as well as monitoring National Weather Service internet and VHF voice broadcasts of current and forecasted marine conditions, real-time weather radar satellite imagery via internet, and mass media weather broadcasts available by satellite on the vessel's TV system.

At the first sign of significant weather, the Port Manager or other on-site designated Person in Charge (e.g., Mooring Master or FLNGV Master), and LNGC Master would determine the Master's needs and plans for storm evasion, such that any order to evacuate would be done in a manner timely enough to allow safe weather evasion. Evacuation due to forecasted weather in excess of the limits below would be ordered by the Port Manager in consultation with the LNGC Master, and in accordance with the Captain of the Port Hurricane and Severe Weather Plan. Proper notifications and consultations with the USCG would be made. Details of actions to be taken in the event of extreme weather will be included in the Applicant's Deepwater Port Operations Manual, which must be approved by the USCG prior to commencement of deepwater port operations.

Wind and sea state thresholds for disconnecting an FLNGV from the TYMS and evading a storm are being developed and will be included in this section.

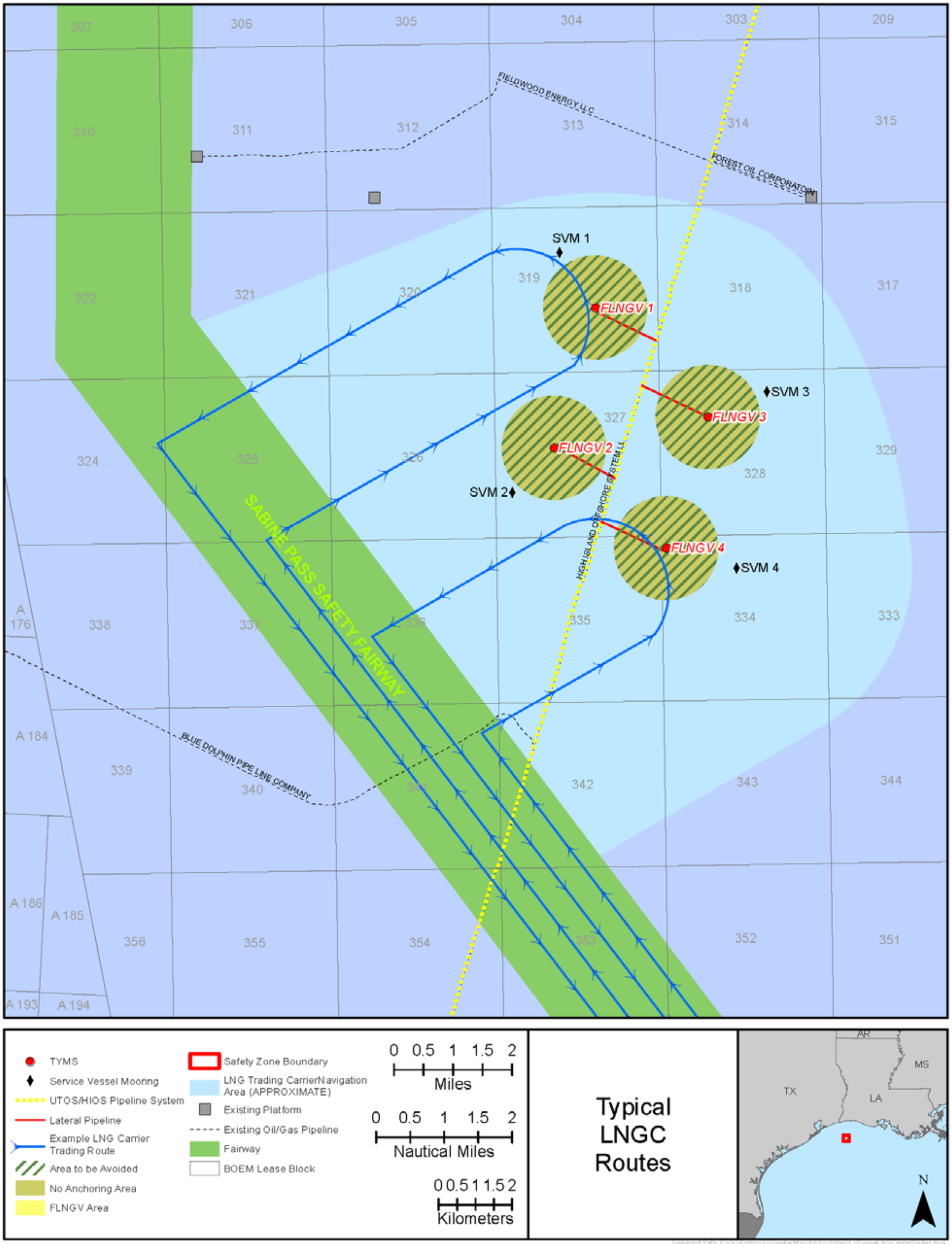

Figure 5.5-3. Typical LNGC Routes

5.6 Offshore Pipeline Safety

The former U-T Offshore System (UTOS)/High Island Offshore System (HIOS) pipeline systems, the proposed WC 167 bypass, and the proposed pipeline laterals are subject to, and the Applicant must comply with, the pipeline safety laws and regulations administered by the PHMSA, Office of Pipeline Safety (49 United States Code [U.S.C.] 601 and 603 and 49 CFR 190-199), including safety standards for design, construction, testing, operation, maintenance, and reporting. Pipe wall thickness, shutoff valve spacing, external pipe protective coating, cathodic protection, underground clearance, and depth of cover would comply with the pipeline safety regulations. Inspection of pipeline welds, materials and external protective pipe coating and hydrostatic testing would be performed prior to placing the pipelines in service. The Applicant would periodically inspect the pipelines to ensure protection from any changes in operating and maintenance conditions including inspection of pipeline after significant events, e.g., earthquakes or hurricanes.

The pipeline components proposed by the Applicant would be designed to accommodate in-line inspection tools (smart pigs) for integrity inspections. Smart pigs have a variety of sensors (e.g., magnetic and ultrasound) to measure the wall thickness of the pipe around the circumference as it travels internally.

The use of smart pigs would provide a reliable record of changes in pipeline conditions to ensure that pipeline integrity is maintained. The frequency of pipeline inspection by pigging and other surveillance measures to confirm integrity would meet or exceed the requirements of all applicable regulations and guidelines.

The Applicant would comply with all applicable regulations regarding operating and maintaining the former UTOS/HIOS pipeline systems and the proposed WC 167 bypass and pipeline laterals. Regulations require a manual of written procedures for operations, maintenance, and emergencies that addresses the following topics:

- Training and qualifications of unsupervised employees and contractor personnel to operate and maintain the pipeline system would be in accordance with all applicable regulations and guidance. Operating procedures would address routine and emergency tasks.[34]
- Periodic in-house training classes would be required for operation and maintenance personnel to maintain qualifications, refresh their understanding of abnormal operating conditions, and review safety, maintenance, operations, and emergency procedures. [35]
- Annual testing and inspection of pressure-limiting devices and emergency shutdown systems would be conducted.
- Patrolling pipeline routes would be conducted at specified time intervals in accordance with the applicable regulations and guidance.
- Measures to ensure that corrosion would be controlled to prevent pipeline leakage and failure.
- Measures to ensure that pipeline integrity would be managed to protect public safety and the environment.

5.6.1 Offshore Pipeline Safety Standards

Offshore pipelines must be designed, constructed, operated, and maintained in accordance with the DOT Minimum Federal Safety Standards under the PHMSA.[36] The regulations are intended to ensure adequate protection for the public and to prevent natural gas facility accidents and failures. The regulations also

[34] 49 CFR 192.605
[35] 49 CFR 192 §§801-809
[36] 49 CFR 192 et seq.

specify material selection and qualification; integrity management; operator qualification; and pipeline protection from internal, external, and atmospheric corrosion.[37]

BOEM, through delegation from the Secretary of the Interior, has authority to promulgate and enforce regulations for the promotion of safe operations, to protect the environment, and conserve natural resources of the OCS, including pipeline transportation of mineral production and the approval of rights of-way for the construction of pipelines and associated facilities on the OCS. Proposed offshore pipelines impacting a fairway or anchorage area must be covered by a right-of-way permit obtained from BOEM.

If the Project is approved, the USCG is responsible for the overall review and approval of the port components, construction, and operations and will coordinate with the PHMSA, BOEM/BSEE, and others as needed for their technical authorities and approval responsibilities.

5.6.2 Offshore Pipeline Incident Data

Table 5.6-1 provides information on offshore natural gas transmission pipeline incidents as reported by the PHMSA. The data presented in Table 5.6-1 are specific to offshore pipelines.

Table 5.6-1. Offshore Natural Gas Transmission Pipeline Incident Summary by Cause

Cause	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012
Corrosion, External	1	0	0	0	1	0	0	0	0	1	2	0	2
Corrosion, Internal	7	2	8	5	11	5	4	9	2	6	14	6	11
Excavation Damage	1	1	0	1	0	0	0	0	0	0	0	1	0
Incorrect Operation	0	0	0	0	0	1	0	0	0	0	0	0	0
Construction/ Material Failure	0	0	2	0	0	4	6	4	2	0	3	2	1
Damage by Natural Force	0	1	2	1	5	32	0	0	18	2	1	0	0
Damage by Outside Force	0	1	2	1	2	5	2	3	0	2	1	4	0
Other	0	0	2	0	0	1	7	4	4	2	1	0	0
Total	**9**	**5**	**16**	**8**	**19**	**47**	**19**	**20**	**26**	**13**	**22**	**13**	**14**

Note: Historic totals might change as the PHMSA receives supplemental information on incidents.
Source: PHMSA (2013)

It should be noted that external corrosion is generally not considered to be a problem for offshore pipelines. The sacrificial anode system has been shown to provide successful lifetime protection against external corrosion (MMS 2004).

5.6.3 Offshore Third-Party Hazards

Damage from outside forces poses the greatest threat to pipeline safety. BOEM and PHMSA require subsea pipelines to be constructed and operated with specifications that minimize these outside forces.[38] It is unlikely that subsea pipelines would pose a significant hazard to public safety or natural gas supply reliability. The

[37] 49 CFR 192 et seq. Design -Subpart C; Construction - Subpart G; Operations - Subpart L; Maintenance - Subpart M. Materials - Subpart B; integrity Management - Subpart O; Operator Qualification - Subpart N; Corrosion Protection - Subpart I

[38] 49 CFR 192.317

Applicant proposes no extraordinary measures beyond regular inspections and maintenance of the former UTOS/HIOS pipeline systems and the proposed WC 167 bypass and pipeline laterals.

Anchor hooking of a pipeline could displace the pipeline to a point where it distorts and structurally fails and could possibly puncture the pipeline, leading to a natural gas leak. The worst credible case for an offshore pipeline rupture would result in a loss of all natural gas occurring along the pipeline's length.

However, any significant damage would be unlikely from this type of event because natural gas would bubble to the surface, dispersing first in the water column and then dissipating in the air. In the highly unlikely event that a ship located in the area provides an ignition source, a fire could develop. Because the methane would be unconfined, there would be no explosion. The resultant fire would be of short duration, but could present a safety risk to individuals on the third-party vessel. An anchor or net snagging the pipeline risers or delivery terminus interconnect could result in damage to the proposed Project's infrastructure or the third-party vessel. The Safety Zone, NAAs, ATBA, and Deepwater Port Operations Manual vessel traffic monitoring and warning procedures would minimize the risk of such incidents.

5.7 Reliability and Safety of Onshore Facilities and Pipelines

The transportation of natural gas by pipeline involves some incremental risk to the public due to the potential for accidental release of natural gas. The greatest hazard is a fire or explosion following a major pipeline rupture.

Methane, the primary component of natural gas, is colorless, odorless, and tasteless. It is not toxic, but is classified as a simple asphyxiate, possessing a slight inhalation hazard. If breathed in high concentration, oxygen deficiency can result in serious injury or death.

Methane has an auto-ignition temperature of 1,000°F (538°C) and is flammable at concentrations between 5.0 percent and 15.0 percent in air. An unconfined mixture of methane and air is not explosive; however, it may ignite and burn if there is an ignition source. A flammable concentration within an enclosed space in the presence of an ignition source can explode. It is buoyant at atmospheric temperatures and disperses rapidly in air.

We acknowledge that some of the below discussion refers to third-party damage and pipeline-specific circumstances that do not apply directly to the proposed Project; however, we are including comprehensive information to better address all safety-related comments received for this Project, and for the public’s benefit.

5.7.1 Safety Standards

The DOT is mandated to prescribe minimum safety standards to protect against risks posed by pipeline facilities under Title 49, U.S.C. Chapter 601. The DOT’s PHMSA administers the national regulatory program to ensure the safe transportation of natural gas and other hazardous materials by pipeline. It develops safety regulations and other approaches to risk management that ensure safety in the design, construction, testing, operation, maintenance, and emergency response of pipeline facilities. Many of the regulations are written as performance standards that set the level of safety to be attained and allow the pipeline operator to use various technologies to achieve safety. PHMSA’s safety mission is to ensure that people and the environment are protected from the risk of pipeline incidents. This work is shared with state agency partners and others at the Federal, State, and local level.

Title 49, U.S.C. Chapter 601 provides for a State agency to assume all aspects of the safety program for intrastate facilities by adopting and enforcing the Federal standards. A state may also act as DOT’s agent to inspect interstate facilities within its boundaries; however, the DOT is responsible for enforcement actions.

For the proposed Project, the State of Louisiana does not have delegated authority to inspect interstate pipeline facilities.

The DOT pipeline standards are published in 49 CFR Parts 190-199. Part 192 specifically addresses natural gas pipeline safety issues.

Under a Memorandum of Understanding on Natural Gas Transportation Facilities dated January 15, 1993, between the DOT and the FERC, the DOT has the exclusive authority to promulgate Federal safety standards used in the transportation of natural gas. Section 157.14(a)(9)(vi) of the FERC's regulations require that an applicant certify that it will design, install, inspect, test, construct, operate, replace, and maintain the facility for which a Certificate is requested in accordance with Federal safety standards and plans for maintenance and inspection. Alternatively, an applicant must certify that it has been granted a waiver of the requirements of the safety standards by the DOT in accordance with section 3(e) of the Natural Gas Pipeline Safety Act. The FERC accepts this certification and does not impose additional safety standards. If the FERC becomes aware of an existing or potential safety problem, there is a provision in the Memorandum to promptly alert DOT. The Memorandum also provides for referring complaints and inquiries made by state and local governments and the general public involving safety matters related to pipelines under the FERC's jurisdiction.

The FERC also participates as a member of the DOT's Technical Pipeline Safety Standards Committee, which determines if proposed safety regulations are reasonable, feasible, and practicable.

The pipeline and aboveground facilities associated with the Project must be designed, constructed, operated, and maintained in accordance with the DOT Minimum Federal Safety Standards in 49 CFR 192. The regulations are intended to ensure adequate protection for the public and to prevent natural gas facility accidents and failures. The DOT specifies material selection and qualification; minimum design requirements; and protection from internal, external, and atmospheric corrosion.

Further, 49 CFR 192.163–192.173 specifically addresses design criteria for compressor stations, including emergency shutdowns and safety equipment. Part 192 also requires a pipeline operator to establish a written emergency plan that includes procedures to minimize the hazards in an emergency.

Additionally, the operator must establish a continuing education program to enable the public, government officials, and others to recognize an emergency at the facility and report it to appropriate public officials. Delfin LNG would provide the appropriate training to local emergency service personnel before the new facilities are placed in service.

The DOT also defines area classifications, based on population density in the vicinity of the pipeline, and specifies more rigorous safety requirements for populated areas. The class location unit is an area that extends 220 yards on either side of the centerline of any continuous 1-mile length of pipeline. The four area classifications are defined below:

- Class 1: Location with 10 or fewer buildings intended for human occupancy.
- Class 2: Location with more than 10 but less than 46 buildings intended for human occupancy.
- Class 3: Location with 46 or more buildings intended for human occupancy or where the pipeline lies within 100 yards of any building, or small well-defined outside area occupied by 20 or more people on at least 5 days a week for 10 weeks in any 12-month period.
- Class 4: Location where buildings with four or more stories aboveground are prevalent.

Class locations representing more populated areas require higher safety factors in pipeline design, testing, and operation. For instance, pipelines constructed on land in Class 1 locations must be installed with a minimum depth of cover of 30 inches in normal soil and 18 inches in consolidated rock. Class 2, 3, and 4 locations, as well as drainage ditches of public roads and railroad crossings, require a minimum cover of 36 inches in normal soil and 24 inches in consolidated rock.

Class locations also specify the maximum distance to a sectionalizing block valve (e.g., 10.0 miles in Class 1, 7.5 miles in Class 2, 4.0 miles in Class 3, and 2.5 miles in Class 4). Pipe wall thickness and pipeline design pressures; hydrostatic test pressures; maximum allowable operating pressure; inspection and testing of welds; and frequency of pipeline patrols and leak surveys must also conform to higher standards in more populated areas. Delfin LNG would construct all compressor station piping in accordance with DOT standards.

No DOT-defined high consequence areas are present in the vicinity of the proposed onshore facilities.

The DOT prescribes the minimum standards for operating and maintaining pipeline facilities, including the requirement to establish a written plan governing these activities. Each pipeline operator is required to establish an emergency plan that includes procedures to minimize the hazards of a natural gas pipeline emergency. Key elements of the plan include procedures for:

- emergency system shutdown and safe restoration of service;
- receiving, identifying, and classifying emergency events, gas leakage, fires, explosions, and natural disasters;
- establishing and maintaining communications with local fire, police, and public officials, and coordinating emergency response;
- making personnel, equipment, tools, and materials available at the scene of an emergency; and
- protecting people first and then property, and making them safe from actual or potential hazards.

The DOT requires that each operator establish and maintain liaison with appropriate fire, police, and public officials to learn the resources and responsibilities of each organization that may respond to a natural gas pipeline emergency, and to coordinate mutual assistance. The operator must also establish a continuing education program to enable customers, the public, government officials, and those engaged in excavation activities to recognize a gas pipeline emergency and report it to appropriate public officials. Delfin LNG would provide the appropriate training to local emergency service personnel before the pipeline is placed in service.

5.7.2 Pipeline Accident Data

The DOT requires all operators of natural gas transmission pipelines to notify the DOT of any significant incident and to submit a report within 30 days. Significant incidents are defined as any leaks that:

- caused a death or personal injury requiring hospitalization; or
- involve property damage of more than $50,000 (1984 dollars).[39]

During the 20-year period from 1996 through 2015, a total of 1,310 significant incidents were reported on the more than 300,000 total miles of natural gas transmission pipelines nationwide.

Additional insight into the nature of service incidents may be found by examining the primary factors that caused the failures. Table 5.7-1 provides a distribution of the causal factors as well as the number of each incident by cause.

[39] $50,000 in 1984 dollars is approximately $115,000 as of March 2014 (CPI, Bureau of Labor Statistics, February, 2014).

Table 5.7-1. Natural Gas Transmission Pipeline Significant Incidents by Cause (1996-2015) a/

Cause	Number of Incidents	Percentage
Pipeline material, weld, or equipment failure	354	27.0
Corrosion	311	23.7
Excavation	210	16.0
All other causes b/	165	12.6
Natural forces c/	146	11.1
Outside force d/	84	6.4
Incorrect operation	40	3.1
Total	**1,310**	**100**

Notes:

a/ All data gathered from the PHMSA's Oracle BI Interactive Dashboard website for Significant Transmission Pipeline Incidents (PHMSA 2016a).

b/ All other causes include miscellaneous, unspecified, or unknown causes.

c/ Natural force damage includes earth movement, heavy rain, floods, landslides, mudslides, lightning, temperature, high winds, and other natural force damage.

d/ Outside force damage includes previous mechanical damage, electrical arcing, static electricity, fire/explosion, fishing/maritime activity, intentional damage, and vehicle damage (not associated with excavation).

The dominant causes of pipeline incidents are corrosion and pipeline material, weld or equipment failure, and excavation, constituting 66.7 percent of all significant incidents. The pipelines included in the data set in Table 5.7-1 vary widely in terms of age, diameter, and level of corrosion control. Each variable influences the incident frequency that may be expected for a specific segment of pipeline.

The frequency of significant incidents is strongly dependent on pipeline age. Older pipelines have a higher frequency of corrosion incidents and material failure, since corrosion and pipeline stress/strain is a time-dependent process.

The use of both an external protective coating and a cathodic protection system,[40] required on all pipelines installed after July 1971, significantly reduces the corrosion rate compared to unprotected or partially protected pipe.

Outside force, excavation, and natural forces are the cause in 33.5 percent of significant pipeline incidents nationwide from 1996 to 2015. These result from the encroachment of mechanical equipment such as bulldozers and backhoes; earth movements due to soil settlement, washouts, or geologic hazards; weather effects such as winds, storms, and thermal strains; and willful damage. Table 5.7-2 provides a breakdown of outside force incidents by cause.

Table 5.7-2. Excavation, Natural Forces, and Outside Force Incidents by Cause (1996-2015) a/

Cause	Number of Excavation, Natural Forces, and Outside Force Incidents	Percentage of All Incidents b/, c/
Third-party excavation damage	172	13.1
Heavy rain, floods, mudslides, landslides	74	5.7
Vehicle (not engaged with excavation)	49	3.7
Earth movement, earthquakes, subsidence	32	2.4
Lightning, temperature, high winds	27	2.1
Operator/contractor excavation damage	25	1.9
Unspecified excavation damage/previous damage	13	1.0

[40] Cathodic protection is a technique to reduce corrosion (rust) of the natural gas pipeline through the use of an induced current or a sacrificial anode (like zinc) that corrodes at faster rate to reduce corrosion.

Table 5.7-2. Excavation, Natural Forces, and Outside Force Incidents by Cause (1996-2015) a/ (continued)

Cause	Number of Excavation, Natural Forces, and Outside Force Incidents	Percentage of All Incidents b/, c/
Other or unspecified natural forces	13	1.0
Fire/explosion	9	0.7
Fishing or maritime activity	9	0.7
Other outside force	9	0.7
Previous mechanical damage	6	0.5
Electrical arcing from other equipment/facility	1	0.1
Intentional damage	1	0.1
Total	**440**	**33.5**

Notes:

a/ All data gathered from the PHMSA's Oracle BI Interactive Dashboard website for Significant Transmission Pipeline Incidents (PHMSA 2016a).

b/ Percentage of all incidents was calculated as a percentage of the total number of incidents natural gas transmission pipeline significant incidents (i.e., all causes) presented in Table 5.7-1.

c/ Due to rounding, column does not equal 33.6 percent.

Older pipelines have a higher frequency of outside forces incidents partly because their location may be less well known and less well marked than newer lines. In addition, the older pipelines contain a disproportionate number of smaller-diameter pipelines; which have a greater rate of outside forces incidents. Small diameter pipelines are more easily crushed or broken by mechanical equipment or earth movement.

Since 1982, operators have been required to participate in "One Call" public utility programs in populated areas to minimize unauthorized excavation activities in the vicinity of pipelines. The "One Call" program is a service used by public utilities and some private sector companies (e.g., oil pipelines and cable television) to provide preconstruction information to contractors or other maintenance workers on the underground location of pipes, cables, and culverts.

5.7.3 Impact on Public Safety

The service incidents data summarized in Table 5.7-3 include pipeline failures of all magnitudes with widely varying consequences.

Table 5.7-3. Injuries and Fatalities – Natural Gas Transmission Pipelines a/

Year	Injuries		Fatalities	
	Employees	Public	Employees	Public
2011	1	0	0	0
2012	3	4	0	0
2013	0	2	0	0
2014	1	0	1	0
2015	12	2	6	0

Note:

a/ All data gathered from the PHMSA Pipeline Incident Flagged Files website (PHMSA 2015).

Table 5.7-3 presents the average annual injuries and fatalities that occurred on natural gas transmission lines for the 5-year period between 2011 and 2015. These data have been separated into those for employees and those for nonemployees to better identify a fatality rate experienced by the general public. Fatalities among the public averaged 1.2 per year over the 5-year period from 2011-2015.

The majority of fatalities from pipelines are due to local distribution pipelines not regulated by FERC. These are natural gas pipelines that distribute natural gas to homes and businesses after transportation through interstate natural gas transmission pipelines. In general, these distribution lines are smaller diameter pipes and/or plastic pipes, which are more susceptible to damage. Local distribution systems typically do not have large rights-of-way and pipeline markers common to the FERC-regulated natural gas transmission pipelines.

The nationwide totals of accidental fatalities from various anthropogenic and natural hazards are listed in Table 5.7-4 in order to provide a relative measure of the industry-wide safety of natural gas transmission pipelines. Direct comparisons between accident categories should be made cautiously, however, because individual exposures to hazards are not uniform among all categories. The data nonetheless indicate a low risk of death due to incidents involving natural gas transmission pipelines compared to the other categories. Furthermore, the fatality rate is much lower than the fatalities from natural hazards such as lightning, tornados, or floods.

The available data show that natural gas transmission pipelines continue to be a safe, reliable means of energy transportation. From 1996 to 2015, there were national averages of 65.4 significant incidents, 9.1 injuries, and 2.3 fatalities per year. The number of significant incidents over the more than 300,000 miles of natural gas transmission lines indicates the risk is low for an incident at any given location. The operation of the Project would represent a slight increase in risk to the nearby public, and we are confident that with implementation of the required design criteria, the new and modified stations would be constructed and operated safely.

Table 5.7-4. Nationwide Accidental Fatalities by Cause

Type of Accident	Annual Number of Deaths
Motor vehicle a/	35,369
Poisoning a/	38,851
Falls a/	30,208
Drowning a/	3,391
Fire, smoke inhalation, burns a/	2,760
Floods b/	81
Tornado b/	72
Lightning b/	49
Hurricane b/	47
Natural gas distribution lines c/	13
Natural gas transmission pipelines c/	2

Notes:

a/ Accident data presented for motor vehicle, poisoning, falls, drowning, fire, smoke inhalation, and burns represent the annual accidental deaths recorded in 2013 (Centers for Disease Control and Prevention 2013).

b/ Accident data presented for floods, tornados, lightning, and hurricanes represent the 30-year average of accidental deaths between 1985 and 2014 (NWS 2016).

c/ Accident data presented for natural gas distribution lines and transmission pipelines represent the 20-year average between 1996 and 2015 (PHMSA 2016b).

6.0 CUMULATIVE IMPACTS

Cumulative impacts are the collective result of the incremental impacts of an action that, when added to the impacts of other past, present, and reasonably foreseeable future actions, would affect the same resources, regardless of what agency or person undertakes those actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time (40 Code of Federal Regulations [CFR] §1508.7). Although the impacts of individual actions taken separately might be minor, the impact of those same actions taken together may be significant for one or multiple resources.

A cumulative impacts analysis focuses on the resources rather than the planned action and considers impacts that take place on both spatial and temporal scales. On a spatial basis, impacts must be considered both within and outside the proposed Project area. Time scales for a cumulative impacts analysis are generally longer than project-specific analysis of impacts. The following types of cumulative impacts (adapted from NRC 1986) are considered, encompassing impacts on both spatial and temporal scales:

- Time-lagging – Frequent and repetitive actions on an environmental system may result in cumulative impacts when the system does not have time to recover from the impacts of one action before the next action occurs. An example of this is overgrazing of pastureland in arid regions.
- Time-lags – Impacts of actions on environmental systems may not appear until an extensive amount of time has elapsed, such as exposure to carcinogens.
- Space-crowding perturbations – Cumulative impacts on the environment arise from high spatial density of actions. An example of this is decreased water quality on a river into which several factories discharge contaminated water.
- Cross-boundary impacts – The impacts of an action are spatially removed from the location of the action. An example of this is groundwater contamination that migrates offsite of the source.
- Fragmentation – An action results in a change in the landscape pattern. Examples of this are construction of an overhead power line through a forest or construction of a highway that would separate a neighborhood community.
- Compounding impacts – Synergistic or collaborative impacts may result from multiple sources or pathways, such as an adverse health impact resulting from the combination of several pesticides in surface runoff.
- Indirect impacts – Secondary impacts may result from a primary action, such as the development of commerce after a roadway is constructed.
- Triggers and thresholds – Fundamental changes in system behavior or structure can occur when a threshold is reached (as in global warming) or when an action becomes a trigger for system change.

The general approach taken for cumulative impacts analysis in this final Environmental Impact Statement (EIS) is to:

- define other activities that could impact resources within the vicinity of the proposed Port Delfin LNG Project (Project);
- assess whether impacts from the proposed Project overlap impacts (in time or space) from other activities, potentially creating any of the types of cumulative impacts listed above;
- total the impacts from the proposed Project with other similar impacts, if impacts are additive and if quantitative information is available, or make a qualitative assessment of total impacts;
- estimate the proposed Project's incremental contribution to total (cumulative) impacts (as a percentage of total, if quantitative);

- assign an impact duration (short- or long-term) and an impact descriptor (minor, moderate, or major) to the proposed Project's contribution to cumulative impacts, and discuss whether an impact is adverse or beneficial to the resource, where possible;
- review mitigation measures for their effectiveness in reducing cumulative impacts and identify further mitigation measures designed specifically to reduce cumulative impacts, if possible; and
- evaluate whether incorporation of specific alternatives into the proposed Project would change the proposed Project's incremental contribution to cumulative impacts.

The cumulative impacts analysis focuses only on impacts that are similar to impacts that would result from the proposed Project. If the proposed Project would not impact a certain resource, specific habitat, or activity, those particular resources, habitats, and activities are not addressed in this cumulative impacts analysis.

Proposed, recommended, or required mitigations may or may not change the incremental contribution of the proposed Project to cumulative impacts. Mitigation requiring avoidance measures that effectively eliminate the impact before the impact occurs, such as minor reroutes of a pipeline to avoid a cultural resource or adjustment of the construction schedule to avoid a species' breeding season, also would eliminate the incremental contribution. Mitigation measures that would reduce the impact or the extent of the impact as the impact occurs, such as turbidity curtains or rip-rap, also would reduce the incremental contribution. Compensatory and other mitigation measures that occur after the impact occurs, such as primary restoration efforts or buying credits to offset the impact, would not reduce or eliminate the incremental contribution to cumulative impacts.

Comments received on the public docket from the Center for Biological Diversity (letters dated August 28, 2015, and August 29, 2016) noted that the EIS should address the indirect impacts of induced natural gas development. However, the scope of this EIS for the proposed Project does not include the production of natural gas. The scope of this final EIS focuses on the direct and indirect impacts of liquefied natural gas (LNG) facilities that are subject to the U.S. Coast Guard's (USCG) and Maritime Administration's (MARAD) Federal action, the licensing of an LNG facility, and the reasonably foreseeable Federal actions of cooperating agencies, including but not limited to the Federal Energy Regulatory Commission (FERC; certificating onshore components of the proposed Project) and the U.S. Environmental Protection Agency (USEPA; permits under the Clean Water Act [CWA] and Clean Air Act [CAA]).

As stated in response to comments from the Center for Biological Diversity discussed above, the scope of this EIS focuses on the direct and indirect impacts of the proposed LNG facility that is subject to MARAD's Federal action, the licensing of the construction and operation of the LNG facility, and the Federal actions of cooperating agencies, including but not limited to the FERC (certificating onshore components of the LNG facility) and USEPA (permitting under the CWA and CAA). In response to the review of the draft EIS, a comment received from the USEPA (by letter dated August 29, 2016) recommended that the final EIS include an estimation of greenhouse gas (GHG) emissions associated with the production, transportation, and combustion of the natural gas proposed to be exported. While this EIS does include an estimation of GHG emissions related to construction, operation, and decommissioning activities, it does not include an analysis of upstream effects from potential induced production or downstream effects from the export of natural gas.

For this Project, Delfin LNG proposes to receive natural gas through its interconnection with other existing natural gas pipelines. The factors described under the Council on Environmental Quality's (CEQ) regulations for a meaningful analysis—including when, where, and how natural gas development would occur as related to the proposed project—are unknown.[41] Additionally, FERC has determined that,

[41] The USEPA suggested that the final EIS consider DOE's *Addendum to Environmental review Documents Concerning Exports of Natural Gas from the United States*, wherein the agency provides additional information to

while upstream development and production of natural gas might be a "reasonably foreseeable" effect of a proposed action, the actual scope and extent of potential GHG emissions from upstream natural gas production is not reasonably foreseeable (see FERC 2015). CEQ's final guidance on evaluating GHG impacts does not require NEPA analyses to include such unforeseeable effects (CEQ 2016).

Regarding downstream GHG emissions from overseas transport, regasification and combustion of exported LNG, Delfin LNG has an application pending before DOE to export LNG to non-free trade agreement nations. The necessary factors for a meaningful analysis, including the demand for LNG exported from this Project, the destination(s) of the exports, the transport routes, and the ultimate end uses of the LNG, are unknown and, as such, the GHG emissions from same are not reasonably foreseeable.[42]

6.1 Past, Present, and Reasonably Foreseeable Future Actions

To identify specific proposals that might impose cumulative environmental effects in the region, Delfin LNG sought information on specific projects, developments, or activities with potential impacts that would overlap in timeframe or geographically with those of the proposed Project. Delfin LNG identified projects by contacting regulatory and planning boards and through publically available information. The projects were screened for review using a standard of 1) having submitted a site plan for review by a local planning agency or government agency, 2) having an application submitted to a regulatory agency for permit review, 3) available press releases, and 4) being within the vicinity of the proposed Project, both the proposed offshore facilities and the Delfin Onshore Facility (DOF) (Tables 6.1-1 and 6.1-2). These projects include LNG processing facilities, shoreline restoration, water infrastructure projects, nearshore oil and gas exploration and production (E&P), maintenance dredging programs, chemical and plastics manufacturing plants, compressor stations, and oil fields and processing facilities. The information in these tables is based on publicly available data.

6.1.1 Deepwater LNG Ports

Since the amendment of the DWPA in 2002 to encompass deepwater ports for natural gas, the USCG and MARAD have received dozens of LNG DWPA license applications for the Gulf of Mexico; however, many applications have been withdrawn before construction. The Louisiana Offshore Oil Port, located near the town of Port Fourchon off the coast of Louisiana, receives and temporarily stores crude oil supplies, providing the single largest point of entry for waterborne crude oil coming into the United

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the public regarding the potential environmental impacts of unconventional natural gas production activities. The Addendum provides GHG emissions information from the upstream natural gas industry as a whole, but DOE recognized that lacking an understanding of where and when additional gas production will arise, the environmental impacts resulting from production activity induced by LNG exports to non-FTA countries are not "reasonably foreseeable" within the meaning of the CEQ NEPA regulations (40 CFR § 1508.7). See DOE (2014 p. 2).

[42] The USEPA suggested that the final EIS consider the analysis prepared by the U.S. Department of Energy's National Energy Technology Laboratory (NETL) in 2014 into the estimated "life cycle" of GHG emissions for exporting LNG from the U.S. In the life cycle analysis, NETL identified two representative markets for U.S. exported LNG—Rotterdam, Netherlands, and Osaka, Japan—then compared the total greenhouse gases that would be emitted to generate one megawatt hour (MWh) of electricity in each market, using: (1) LNG imported from the United States; (2) LNG imported from closer regional sources; (3) natural gas exported via pipeline from Russia; and (4) regional coal. In each scenario, NETL considered carbon dioxide and methane emissions from all stages of fuel production, from extraction to final combustion. NETL concluded that exporting U.S. LNG to produce power in Europe and Asia will not increase greenhouse-gas emissions compared to regional coal power, and that potential differences in greenhouse-gas emissions relating to the use of U.S. LNG, regional LNG, or Russian gas are largely limited to "transport distance" and are otherwise "indeterminate" due to uncertainty in the modeling data. Additionally, NETL concluded that no significant increase or decrease in net climate impact is anticipated from any of these scenarios (see NETL 2014, § 7 Summary and Study Limitations, p. 18). Because NETL analyzed representative approaches for U.S. LNG exports, the general conclusions regarding GHG emissions from such exports are expected to apply to this Project.

States. This port is located 180 nautical miles from the proposed Project (LOOP 2016). The Louisiana Offshore Oil Port is exploring the possibility of making facility modifications to allow for export of crude. No other deepwater port—proposed, approved, or constructed—is located within 80 nautical miles of the proposed Project.

6.1.2 Onshore LNG Terminals

There are several liquefaction and export projects that are proposed, planned, or under construction in the vicinity of the proposed Project. There are currently 16 proposals for LNG import/export facilities within the Gulf Coast region. Of the 16 facilities, only 3 are existing facilities: Freeport LNG, Sabine Pass LNG, and Cameron LNG. Of these 3 facilities, only the Cheniere Energy, Inc. Sabine Pass facility is operating as an export facility with the first export completed in February 2016. A total of 14 LNG import/export terminals in the Gulf of Mexico have received authorization to commence construction; however, only 1 import/export terminal, located in Corpus Christi, Texas, and 5 export terminals, located in Louisiana and, Texas, are under construction within the Gulf of Mexico (FERC 2016a, 2016b, and 2016c).

As shown in Figure 6.1-1, there are several proposed LNG import/export terminals within 20 miles of the proposed Project area. Only one of these projects, the Sabine Pass LNG Export Terminal by Cheniere Energy, Inc., is currently under construction with regard to expansion at an operational facility. The other projects are in various phases of development and the regulatory approval process. The terminals would be located onshore on the Calcasieu Ship Channel; therefore, vessels traveling to and from these facilities would likely use the fairways near the proposed Project. Sempra Energy's Cameron LNG Project is located approximately 25 miles northwest of the proposed DOF in Hackberry, Louisiana. This project is under construction and is scheduled to bring three trains online in 2018 (EIA 2016b). This terminal would also result in additional transits of fairways near the proposed Project. These terminals were considered in this cumulative impact analysis.

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project

Project	Location	Timeframe	Description	Expected Environmental Effects
Sabine Pass LNG Export Terminal (Cheniere Energy, Inc.) a/	Cameron Parish	Operational for trains 1 and 2; Operation estimated 2016/2017 for trains 3 and 4. Permitting was initiated for trains 5 and 6 in early 2013.	▪ Six new liquefaction trains, each with nominal capacity of approximately 4.5 MMtpa (approximately 0.5 Bcf/day each). ▪ 3,000 construction jobs, 77 retained jobs, 356 new permanent direct jobs (206 new/150 resident contractors), 589 new permanent indirect jobs, $100,000 average salary. ▪ $11 billion capital investment. ▪ Cheniere Creole Trail Pipeline, L.P. would add approximately 98.7 miles of pipeline, including two loops (Loop 1 and Loop 2), an extension, three laterals, and a new compressor station.	▪ Groundwater use during construction; municipal water during operations ▪ Major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce and housing requirements (new jobs); use of public services; capital investments and tax revenue
Golden Pass LNG b/	Sabine Pass, Texas	In permitting; Expected operation in 2018–2020	▪ Expansion of existing facility for export of 15.6 million tons of LNG per year (approximately 2 Bcf/day). The new facility would be built on existing Golden Pass property and utilize the existing state- of-the-art tanks, berths and pipeline infrastructure. New facilities for natural gas pre-treatment and liquefaction would be constructed. ▪ Pipeline upgrades would include installation of approximately 8 miles of 30- to 36-inch pipeline and installation of additional compressor stations.	▪ Groundwater use during construction; municipal water during operations ▪ Additional security vessels that temporarily prohibit recreational use on the Sabine River ▪ Major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce and housing requirements (new jobs); use of public services; capital investments and tax revenue
Waller Point LNG (Waller Energy Holdings, LLC and Waller LNG Services, LLC) c/	Entrance of the Calcasieu Ship Channel, Cameron Parish	Proposed	▪ Plan to export domestically produced LNG of approximately 1.3 MMtpa (approximately 0.2 Bcf/day) up to the equivalent of 58.4 Bcf of natural gas per year to FTA countries using a proprietary floating storage tank (NO92 Membrane) at the facility.	▪ Groundwater use during construction; municipal water during operations ▪ Additional security vessels that temporarily prohibit recreational use ▪ Potentially major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce and housing requirements (new jobs); use of public services; capital investments and tax revenue

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Gasfin Development USA, LLC d/	Along the Calcasieu River, Cameron Parish	Application approved; Proposed operational start in 2019	▪ Received long-term authorization from DOE to export to FTA countries approximately 1.5 MMtpa (approximately 0.2 Bcf/day) up to 74 Bcf per year of natural gas domestically produced LNG from a proposed mid-scale natural gas liquefaction and LNG export terminal.	▪ Groundwater use during construction; municipal water during operations ▪ Additional security vessels that temporarily prohibit recreational use ▪ Potentially major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce (new jobs); use of public services; capital investments and tax revenue
Venture Global LNG, LLC e/	Along the Calcasieu River, Cameron Parish	Permitting	▪ Export of approximately 5 MMtpa (approximately 0.7 Bcf/day) up to 244 Bcf per year of natural gas domestically produced LNG from a proposed mid-scale natural gas liquefaction and LNG export terminal.	▪ Groundwater use during construction; municipal water during operations ▪ Additional security vessels that temporarily prohibit recreational use ▪ Major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce (new jobs); use of public services; capital investments and tax revenue
SCT & E LNG f/	Monkey Island, Cameron Parish	Permitting Construction to begin 2016–2017	▪ Received long-term authorization from DOE to export to FTA countries 584 Bscf/yr (1.6 Bscf/d) of natural gas (approximately equivalent to 12 MMtpa LNG) ▪ Capital investment $9.25 billion, 2,000 construction jobs, 200 permanent jobs ▪ Six trains to be built in three phases (each train with nominal capacity of 2 MMtpa LNG)	▪ Groundwater use during construction; municipal water during operations ▪ Additional security vessels that temporarily prohibit recreational use ▪ Potentially a major air emission source ▪ Noise during construction ▪ Addition of new large LNG storage tanks ▪ Workforce (new jobs); use of public services; capital investments and tax revenue
Cameron LNG Liquefaction Facilities Expansion g/	Cameron Parish, Louisiana	Construction began in October 2014, with commercial operation expected to begin in 2018.	▪ Received long-term authorization from DOE to export to FTA and non-FTA counties ▪ Construction of three liquefaction trains capable of exporting 1.7 Bscf/day of liquefied natural gas ▪ Expansion project in Hackberry, Louisiana to include two additional liquefaction trains and ▪ One additional full containment LNG storage tank ▪ Located on land within existing Cameron LNG terminal site	▪ Groundwater use during construction; municipal water during operations ▪ Major air emission source ▪ Noise during construction ▪ Addition of one full containment LNG storage tank and two liquefaction trains ▪ Workforce and housing requirements (new jobs); use of public services; capital investments and tax revenue

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Sabine-Neches Channel Improvements h/	Jefferson County, TX	Dredging 1 or 2 times per fiscal year for the bar channel, every other year for inland reaches, and every 5 to 8 years for uppermost reaches; 2015–2021.	▪ Deepen the Sabine-Neches Waterway from 40 feet to 48 feet. ▪ Allow larger ships to reach local ports. ▪ $748 Federal funds.	▪ Minor, short-term impacts on water and sediment quality, marine and coastal habitats, sound propagation, and noise
Alligator Bayou Pump Station Annex i/	Port Arthur, TX	Under construction	▪ $60 million pump station to manage area's canal system ▪ 25-year storm pumping capacity at PS 16. ▪ Construction footprint 17.2 acres.	▪ Impacts on 1.3 acres of wetlands
Oil and Gas E&P – Central Planning Area Lease Sales j/	Cameron Parish, Louisiana	2012–2017	▪ Proposed lease sales in the GOM. Oil and gas activities may occur on OCS leases after a lease sale pursuant to the proposed action and the activities may extend over a period of 40 to 50 years. ▪ Activities could include seismic surveys, drilling oil and natural gas exploration and production wells, installation and operation of offshore platforms and pipelines, onshore pipelines, and support facilities, and transporting oil using ships or pipelines.	▪ Erosion and runoff, sediment disturbance and turbidity, vessel discharges, and accidental releases of oil, gas, or chemicals
Calcasieu River and Pass, LA, Dredged Material Management Plan (DMMP) k/	From the GOM up to Lake Charles, LA, from the pass and along the Calcasieu River	Dredging 1 or 2 times per fiscal year for the bar channel, every other year for inland reaches, and every 5 to 8 years for uppermost reaches; continuous maintenance throughout channel.	▪ Dredging to provide deep draft access to the Port of Lake Charles, and development of a salt-water barrier structure.	▪ Minor, short-term impacts on water and sediment quality, marine and coastal habitats, sound propagation, and noise

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Cameron Parish Shoreline Restoration (Louisiana Coastal Protection and Restoration Authority) l/	Cameron Parish, Louisiana	50-year master plan that started in 2012	▪ $45.8 million project involving a 9-mile stretch of GOM coast, and dredging sand resource blocks ▪ Five of the proposed offshore sand resource blocks are within Port Delfin LNG Project sites ▪ Part of a 50-year master plan to combat and reverse coastal land loss.	▪ Impacts on proposed offshore FLNGV locations
East Hackberry Field, M P Erwin Production Facility, Gulfport Energy Corporation (GPOR) m/	Cameron Parish, Louisiana	Operational	▪ Oilfield	▪ Air emission source
Mako Compressor Station, Targa Midstream Services, LLC n/	Cameron Parish, Louisiana	Operational	▪ Compressor Station	▪ Air emission source
Sempra U.S. Gas & Power, Cameron Interstate Pipeline Expansion Project o/	Cameron Parish and Calcasieu Parish, Louisiana	Fourth Quarter 2014 is the start of construction, and third quarter 2016 is the project in-service projection date.	▪ Expansion would consist of modifications to Cameron Interstate Pipeline's existing gas transmission system in Beauregard, Calcasieu, and Cameron Parishes to receive and transport domestic natural gas to the proposed liquefaction project at the Cameron LNG Terminal in Hackberry, LA. ▪ Following facilities would be constructed: approximately 21 miles of 42-inch-diameter pipeline (only part of which would run through a 50-km radius of the Project site), a new compressor station with 12 CAT G3616 natural gas-driven compressors, a new interconnect with the Trunkline Pipeline, and modifications to existing pipeline interconnections.	▪ Groundwater use during construction; municipal water during operations ▪ Major air emission source ▪ Noise during construction ▪ Addition of 21 miles of 42-inch-diameter pipeline, and a compressor station ▪ Workforce and housing requirements (new jobs); use of public services; capital investments and tax revenue

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Gulf Trace Expansion Project - Transcontinental Gas Pipe Line Company, LLC (Transco) p/	Cameron Parish, Louisiana	Scheduled to commence January 2016 at compressor stations and June 2016 on the pipeline to meet a target in-service date of January 1, 2017.	▪ Addition of two 16,000 International Organization for Standardization horsepower gas turbine-driven compressor units at Transco's existing Compressor Station 44 in Cameron Parish	▪ Impacts on air quality adjacent to the proposed DOF
West Hackberry Oil Field, Gulfport Energy Corporation (GPOR) m/	Cameron Parish, Louisiana	Operational	▪ Oilfield	▪ Air emission source
Stingray Gas Plant, Targa Midstream Services, LLC (1) g/	Cameron Parish, Louisiana	Operational	▪ Gas Plant facility	▪ Air emission source
Stingray Gas Plant, Targa Midstream Services, LLC (2) g/	Cameron Parish, Louisiana	Operational	▪ Gas Plant facility	▪ Air emission source
Kinetica Partners, LLC Station 821E1 r/	Cameron Parish, Louisiana	Operational	▪ Compressor Station	▪ Air emission source
Kinder Morgan, Inc. Natural Gas Pipeline Company of America, Compressor Station #342 s/	Cameron Parish, Louisiana	Operational	▪ Compressor Station	▪ Air emission source

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Oxbow Calcining, LLC t/	Jefferson County, Texas	Operational	▪ Calcined Pet Coke Plant. The facility has the capacity to produce 700,000 short tons per year of anode and industrial grade calcined petroleum coke. This site also has a primary laboratory and testing facility.	▪ Air emissions source
Chevron Phillips Chemical Company u/	Jefferson County, Texas	Operational	▪ A chemical-producing facility	▪ Air emissions source
Vidor Compressor Station (1) v/	Orange County, Texas	Operational	▪ Compressor station situated on the Texas Eastern Transmission (TETCO) pipeline.	▪ Air emissions source
Vidor Compressor Station (2) v/	Orange County, Texas	Operational	▪ Compressor station situated on the TETCO pipeline.	▪ Air emissions source
Kinder Morgan Sabine Compressor Station w/	Orange County, Texas	Operational	▪ Compressor Station	▪ Air emissions source
Williams Gas Pipeline/Transco Station 44	Cameron Parish, LA	Operational	▪ Compressor Station	▪ Air emissions source

Key:

Bcf/day = billion cubic feet per day; Bscf/yr = billion square cubic feet per year; DOE = U.S. Department of Energy; FLNGV = floating liquefied natural gas vessel; FTA = Free Trade Agreement; GOM = Gulf of Mexico; km = kilometer; LNG = liquefied natural gas; MMtpa = million tons per annum; OCS = Outer Continental Shelf

Sources:

a/ http://energy.gov/sites/prod/files/2014/02/f7/Summary%20of%20LNG%20Export%20Applications.pdf

b/ Golden Pass Products (n.d.)

c/ Maritime Activity Reports Inc. (n.d.); DOE (n.d.); http://www.fossil.energy.gov/programs/gasregulation/authorizations/2013_applications/13_153_LNG.pdf

d/ Gasfin Development SA (n.d.)

e/ http://venturegloballng.com/; DOE (n.d.)

f/ SCT&E LNG (n.d.)

g/ Cameron LNG (n.d.)

h/ Sabine Neches Navigation District (n.d.)

i/ http://www.swg.usace.army.mil/Portals/26/docs/Planning/Notice%20of%20AvailabilityAB.pdf

j/ BOEM 2016; Data.boem.gov (2016)

k/ Mvn.usace.army.mil (2016)

Table 6.1-1. Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects

l/ Coastal.la.gov (2016)
m/ Gulfportenergy.com (2016); Reuters (2016)
n/ LDEQ (2015)
o/ Sempra U.S. Gas & Power (2016)
p/ FERC (2015b)
q/ http://www.onrr.gov/ReportPay/PDFDocs/Gas_Plant_Listing.pdf
r/ Usa.com (2016a)
s/ Usa.com (2016b)
t/ Homefacts.com (2016)
u/ Cpchem.com (2016)
v/ Epa-sites.findthedata.com (2016)
w/ Usa.com (2016c)

Table 6.1-2. Non-Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project

Project	Location	Timeframe	Description	Expected Environmental Effects
Sterling Shipyard a/	Humble Island, Orange Co., Texas	Unknown	▪ Construction of a shipbuilding facility ▪ Addition of 200 jobs	▪ Noise during construction
Cameron Parish Shoreline Restoration (Louisiana Coastal Protection and Restoration Authority) b/	Cameron Parish, Louisiana	50-year master plan that started in 2012	▪ $45.8 million project involving a 9-mile stretch of GOM coast, and dredging sand resource blocks ▪ Five of the proposed offshore sand resource blocks are within Port Delfin LNG Project sites ▪ Part of a 50-year master plan to combat and reverse coastal land loss.	▪ Impacts on proposed offshore FLNGV locations
Cameron Meadows Gas Processing Plant, PSI Midstream c/	Cameron Parish, Louisiana	Operational	▪ Gas Processing plant consists of two trains (the Johnson's Bayou Train, and the Cameron Train) 200 MMcfd and 300 MMcfd respectively.	▪ Air emission source
KMCO Port Arthur d/	Jefferson County, Texas	Operational	▪ Custom chemical manufacturing and custom processing – specializing in custom processing of petrochemicals, specialty chemicals, oleochemicals, agricultural chemicals, industrial and food-grade chemicals.	▪ Air emissions source
Valero Port Arthur Refinery e/	Jefferson County, Texas	Operational	▪ Oil Refinery	▪ Air emissions source
Praxair Port Arthur Hydrogen Facility f/	Jefferson County, Texas	Operational	▪ Hydrogen plant serving the Valero Port Arthur Refinery.	▪ Air emissions source
Motiva Enterprises LLC Refinery g/	Jefferson County, Texas	Operational	▪ Oil refinery	▪ Air emissions source
Groves Compressor Station, UCAR Pipeline Inc. h/	Jefferson County, Texas	Operational	▪ Compressor Station	▪ Air emissions source
TPC Group Chemical Plant i/	Jefferson County, Texas	Operational	▪ Chemical plant that can produce up to 900 million pounds of butadiene per year.	▪ Air emissions source

Table 6.1-2. Non-Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Air Liquide – Port Neches Air Separation Unit (ASU) Cogeneration Plant j/	Jefferson County, Texas	Expected commercial production at the end of 2015	▪ The new ASU would produce oxygen, nitrogen, and argon at its Port Neches facility ▪ Hiring of additional operators and technicians	▪ Workforce (new jobs) ▪ Air emissions source
Port Neches Operations C4 Plant k/	Jefferson County, Texas	Operational	▪ This facility houses petrochemical manufacturing	▪ Air emissions source
Lion Elastomers, LLC l/	Jefferson County, Texas	Operational	▪ Privately owned. Manufactures and supplies emulsion styrene butadiene rubber	▪ Air emissions source
Brock Services, LLC m/	Jefferson County, Texas	Operational	▪ Custom sandblasting service	▪ Air emissions source
Lucite International, Inc. n/	Jefferson County, Texas	Operational	▪ Plastics manufacturing, producing MMA using ACH technology	▪ Air emissions source
DuPont Sabine River Works o/	Orange County, Texas	More than one-third of the $100 million investment is expected to be installed by the end of 2015. Expected completion in 2018.	▪ Chemical plant – pesticides and agricultural chemicals ▪ Expansion project to increase packaging and industrial polymers capacity. ▪ Increasing production capacity of its ethylene copolymers assets at its Texas manufacturing facilities to meet growing market demand. ▪ Increase in industrial construction employment	▪ Air emissions source ▪ Workforce (more jobs)
Firestone Polymers LLC p/	Orange County, Texas	Operational	▪ Synthetic rubber manufacturing	▪ Air emissions source
Sabine Cogeneration Facility, Electric Utility Company q/	Orange County, Texas	Operational	▪ Cogeneration facility	▪ Air emissions source

Table 6.1-2. Non-Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects
Lanxess Energizing Chemistry r/	Orange County, Texas	Operational	▪ Rubber manufacturing	▪ Air emissions source
Orion Engineered Carbons, LLC s/	Orange County, Texas	Operational	▪ Echo Carbon Black Plant Wharf	▪ Air emissions source
Invista t/	Orange County, Texas	Operational	▪ Polymers and fibers manufacturing primarily for nylon, spandex, and polyester applications.	▪ Air emissions source
Invista S.A.R.L. – Orange Site t/	Orange County, Texas	Operational	▪ Plastics material, synthetic resins, and nonvulcanizable elastomer manufacturing	▪ Air emissions source
Honeywell International Inc. u/	Orange County, Texas	Operational	▪ Aircraft engine and engine parts manufacturing	▪ Air emissions source
Solvay Solexis v/	Orange County, Texas	Operational	▪ Plastic Fabrication Company – plastics and resin manufacturing	▪ Air emissions source
Crosstex Energy Services w/	Cameron Parish, LA	Operational	▪ Processing Facility	▪ Air emissions source

Key:
DOF = Delfin Onshore Facility; FLNGV = floating liquefied natural gas vessel; GOM = Gulf of Mexico; LNG = liquefied natural gas; MMcfd = million cubic feet per day

Sources:
a/ Murdock (2015)
b/ Coastal.la.gov (n.d.)
c/ PSI Midstream (n.d.)
d/ KMCO Inc. (n.d.)
e/ valero.com (n.d.)
f/ McCarthy (2013)
g/ Motiva Enterprises (n.d.)
h/ USEPA (n.d.)
i/ TCP Group (n.d.)
j/ Brown (2014)
k/ Usa.com (2016d)

Table 6.1-2. Non-Federal Projects Identified for Consideration in the Cumulative Impacts Analysis for the Proposed Port Delfin LNG Project (continued)

Project	Location	Timeframe	Description	Expected Environmental Effects

l/ Lion Elastomers (n.d.)
m/ Brock Group (n.d.)
n/ Lucite International (n.d.)
o/ Ball (2014)
p/ Firestone Polymers (n.d.)
q/ Public Utility Commission of Texas (n.d.)
r/ Laxness (n.d.)
s/ Orion(n.d.).
t/ Stutzman (2012)
u/ AMFIBI.com (n.d.)
v/ Solvay Solexis (n.d.)
w/ Young (2014)

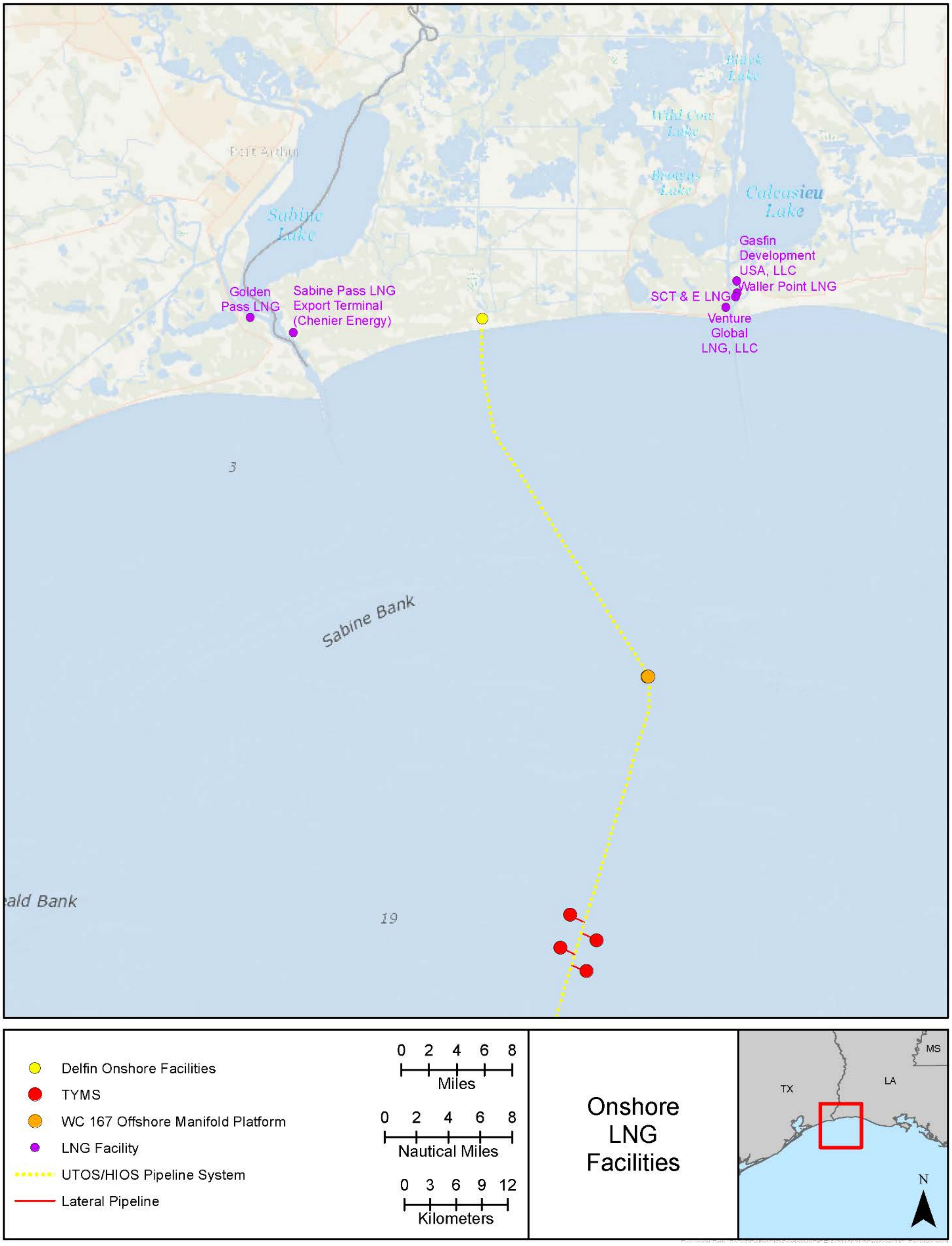

Figure 6.1-1. Onshore LNG Facilities

6.1.3 Oil and Gas Activity

The proposed Project is located in the Bureau of Ocean Energy Management's (BOEM) Central Planning Area for offshore oil and gas activity. According to a BOEM offshore energy resource assessment, this area, which includes the offshore waters adjacent to Louisiana, Mississippi, and Alabama, has the largest volume of untapped oil and gas resources among all Outer Continental Shelf (OCS) regions (BOEM 2011c). For leasing purposes, the OCS is divided into protraction areas, which are further divided into numbered lease blocks. Oil and gas activities may occur on OCS leases after a lease sale and may extend over a period of 40 to 50 years. Per BOEM's 2012–2017 Five Year OCS Oil and Gas Program, 64.5 million acres of the Central Gulf Planning Area will be open to bidding in this cycle, representing 29.5 percent of all OCS acreage open for bidding (BOEM 2012c).

Onshore oil and gas activity in the proposed Project area includes development, construction, and operation of oil fields, oil refineries, and gas/natural gas liquids processing plants in Cameron Parish, Louisiana, and Jefferson County, Texas.

Current and future oil and gas activity in and around the proposed Project, both offshore and onshore, was considered in this cumulative impact analysis.

6.1.4 Pipeline System Projects

Several pipeline systems in the proposed Project area currently operation or are planning to install compressor stations, including addition of two 16,000 horsepower (hp) gas turbine-drive compressor units at Transcontinental's (Transco's) existing Compressor Station 44 where a compressor station is already operational. Three additional compressor stations are operational in Cameron Parish, Louisiana, under Targa Midstream Services, LLC, Kinetica Partners, and Kinder Morgan, Inc. One compressor station for UCAR Pipeline Inc. is operational in Jefferson County, Texas. Two compressor stations on Spectra's Texas Eastern Transmission pipeline and one compressor station at Kinder Morgan's Sabine Compressor Station are also operational in Orange County, Texas.

Sempra U.S. Gas & Power is targeting a third quarter 2016 in-service data for the Cameron Interstate Pipeline Expansion Project, which includes modification to the existing gas transmission system in Beauregard, Calcasieu, and Cameron Parishes. Facilities would include approximately 21 miles of 42-inch pipeline, a new compressor station, a new interconnect with the Trunkline Pipeline, and modifications to existing pipeline interconnections.

6.1.5 Utilities

Two cogeneration facilities are under construction or operational in the proposed Project area. The 105-megawatt Sabine Cogeneration Facility in Orange County, Texas has been operational since 1999, and supplies power and steam to the adjacent Lanxess Corporation chemical facility and the Midcontinent Independent System Operator market. Air Liquide Large Industries U.S. LP started construction on a new Air Separation Unit that would produce oxygen, nitrogen, and argon at a production facility in Port Neches, Jefferson County, Texas. The new Air Separation Unit was expected to begin commercial production by the end of 2015; however, updated information on the current status of this project is not readily available.

6.1.6 Other Industrial Facilities

The proposed Project area is surrounded by several operating and planned manufacturing plants including chemical manufacturing and processing plants with associated laboratories and testing facilities, and plastics and petrochemical manufacturing in Jefferson and Orange Counties, Texas, and aircraft engine and engine parts manufacturing in Orange County, Texas. With the exception of the DuPont Sabine River Works chemical plant, which is targeting 2018 completion of expansion activities, other industrial facilities included in this cumulative impact analysis are already operational and are only included with regard to cumulative impacts on noise and air.

6.1.7 Commercial and Residential Developments

Future commercial development projects in the proposed Project area are limited to the construction of the Sterling Shipyard in Orange County, Texas. The timeline for construction and operation of this shipyard is unknown as funding and securing of commercial electrical power is still in development. Acquisition of a 400-acre site was completed in January 2016 (TheRecordLive 2016).

There is no planned residential development in the proposed Project area.

6.1.8 Federal, State, and/or Municipal Government Activities

Future Federal, State, and/or municipal government activities include channel management, improvements, and dredging, and shoreline restoration, including activities associated with the Sabine-Neches Channel in Jefferson County, Texas, the Alligator Bayou in Port Arthur, Texas, and the shoreline in Cameron Parish, Louisiana. These three projects were considered in this cumulative impact analysis.

6.2 Potential Cumulative Impacts by Resource Area

Potential cumulative impacts are described by resource area in the following subsections.

6.2.1 Water Resources

Activities that could impact water resources within the vicinity of the proposed Project include construction and operation of LNG terminals, offshore pipelines, and associated vessel traffic; marine traffic associated with the offshore oil and gas industry; and channel management and improvements. These activities could generate impacts related to marine currents, water temperature, turbidity and sediments, dissolved oxygen, and contaminated sediments, and could generate marine debris, inadvertent spills, releases of hazardous materials, and testing and maintenance discharges.

The potential for overlap of water quality impacts with other projects in the vicinity during construction, operation, and decommissioning would be very unlikely given that water quality impacts would likely be restricted to the immediate area of the activity, even if two projects have concurrent construction schedules. Siting of the proposed DOF on land currently used for an existing compressor station minimizes the contribution of the proposed Project on cumulative impacts on water resources including wetlands.

The contribution to cumulative impacts on water resources is expected to be short-term and minor during construction of the proposed Project, and long-term and minor during operation. Impacts would be localized and are not expected to overlap greatly with similar impacts from other facilities.

Use of a fixed platform-based unit would likely require a greater level of water intake and discharge than the proposed Project, which would increase the cumulative impact on water resources as compared to the proposed action. Turbidity and seafloor disturbance would be similar for alternative deepwater port designs. Use of an open-loop, water cooled heat exchanger as an alternative cooling media would require substantially more seawater for the cooling process, increasing the cumulative impact on water resources as compared to the proposed action. Water use and discharge for alternative anchoring methods would be similar to those expected from the proposed action; however, installation of driven piles would result in a smaller footprint whereas as a gravity-based anchor would result in a greater footprint, which would increase the cumulative impact on turbidity, sedimentation, and seafloor disturbance. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on water resources would be similar to the proposed action.

6.2.2 Biological Resources

Cumulative impacts on biological resources include discussions of threatened and endangered species, marine habitats, non-threatened and non-endangered species, plankton, and fisheries resources.

Activities that could impact biological resources, including threatened and endangered species, within the vicinity of the proposed Project include construction and operation of marine traffic associated with the offshore oil and gas industry and other pipeline installation; and channel management and improvements. These activities could generate impacts resulting in degradation of water quality, increased vessel traffic and vessel strikes, increased noise, and inadvertent spills and marine debris; onshore, these activities could result in removal of vegetation, habitat alteration, wildlife displacement, and introduction of invasive plant species. The operation and decommissioning of the proposed Project, both of which would have much lower impacts than construction, would also not be cumulatively significant when compared to other ongoing and future (U.S. Army Corps of Engineers and oil and gas E&P) marine/coastal activities. Offshore E&P activities can include installation/removal of mooring platforms and laying of pipelines and associated anchoring activities, service vessel operations, supporting infrastructure discharges, and oil spills. Many of these activities can increase oceanic noise levels and decrease water quality, especially if they occur simultaneously. In light of the substantial number of tug and supply vessel trips serving the region, cumulative effects of noise to coastal/marine habitats and their biological resources, including threatened and endangered species, during all proposed Project phases would be negligible.

The cumulative impacts on water quality of the marine environment can result from the addition of discharges from E&P activities to the environment, especially if these activities coincide with proposed Project construction, as impacts are expected to be greatest during construction. It is anticipated that other projects would be required to obtain necessary permits with regard to water quality and discharge. Therefore, the cumulative adverse impacts on water quality are not expected to be major. Generally, the low impact nature of the proposed Project during construction, operation, and decommissioning would not result in major cumulative impacts on habitats that support marine biological communities in the Gulf of Mexico.

There would be little potential for overlap of the proposed Project with other similar facilities' impacts due to the distance between these projects and the localized nature of impacts on biological resources, including threatened and endangered species; however, overlap and additive impacts from the proposed Project with other activities would include increased risk of collisions with the offshore larger marine mammals from the increase in vessels traveling to and from each facility (travel paths may overlap). Additionally, there would be a decrease in inactive habitat or water areas free from these stressors in which species, particularly ESA-listed marine mammals or sea turtles, might move to in order to avoid the noise and disturbance from other facilities or projects. It is assumed that fish and invertebrate species and their associated habitat already regularly undergo disturbances, either from direct loss via fishing/trawling harvest or from vessel traffic and anchoring, suggesting that the proposed Project area is already regularly disturbed by human activities. The offshore construction zone is located just outside the major shipping channel(s) into the ports of Lake Charles, Louisiana, and Beaumont/Sabine Lake, Texas; therefore, no commercial vessel traffic would be transiting the immediate proposed Project area. Overall, the incremental contribution to cumulative impacts on biological resources, including threatened and endangered species, would be long-term and minor. Present and future projects may increase vessel traffic in the area but the contribution of the proposed action to cumulative impacts on biological resources is negligible (less than one percent increase in vessel traffic). Similarly, underwater sound levels resulting from the proposed action would be minor. Future projects would begin after the Proposed Action is completed, so no additive effects of noise would occur. Assuming other future projects do occur, the contribution of the Proposed Action to cumulative effects on biological resources resulting from noise would be negligible.

Although onshore activities can potentially impact the marine environment and the biological resources that have habitat there, it is more than likely that other onshore projects would not result in additive negative impacts when considered in concert with any phase of the proposed Project. Biological resources both onshore and nearshore in the proposed DOF is previously disturbed and currently being actively used for both commercial and other industrial operations. The proposed Project area is heavily utilized for oil and gas activities and there is a large number of associated vessels in the nearshore environment and an active human presence in the area already causing disturbance. The cumulative impact area for vegetation, fisheries, and wildlife resources includes the area within 5 miles of the proposed DOF and the non-jurisdictional components; the proposed DOF is not anticipated to have an additive effect on biological resources with other development projects outside a 5-mile radius from the proposed DOF.

Since alternative deepwater port designs, cooling media, anchoring systems, and compressor station designs would use the same proposed Port and DOF locations, the contribution to cumulative impacts on biological resources, including threatened and endangered species, would be similar to the Proposed Action. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on biological resources, including threatened and endangered species, would be similar to the Proposed Action.

6.2.3 Essential Fish Habitat

Activities that could impact essential fish habitat (EFH) within the vicinity of the proposed Project include construction and operation of deepwater ports and offshore pipelines and associated vessel traffic; marine traffic associated with the offshore oil and gas industry; and channel management and improvements. These activities could generate impacts on EFH due to degradation of water quality, reduction of habitat, vessel traffic, noise, and inadvertent spills and marine debris.

There would be little potential for overlap of the proposed Project with other similar facilities' impacts due to the distance between these projects and the localized nature of impacts on EFH. The incremental contribution to cumulative impacts on EFH would be long-term and minor.

Use of a fixed platform-based unit would destroy a larger area of soft-bottom EFH than the proposed Port; however, impacts on water column EFH would be similar to those expected for the proposed Project. Use of an open-loop, water cooled heat exchanger as an alternative cooling media would require substantially more seawater for the cooling process, increasing the cumulative impact on biological resources including EFH as compared to the proposed action. Water use and discharge for alternative anchoring methods would be similar to those expected from the Proposed Action; however, installation of driven piles would result in a smaller footprint whereas as a gravity-based anchor would result in a greater footprint, which would increase the cumulative impact on turbidity, sedimentation, and seafloor disturbance, thereby increasing the cumulative impact on EFH.

6.2.4 Geological Resources

Activities that could impact geological resources within the vicinity of the proposed Project include ground and seabed disturbance associated with construction of deepwater ports, onshore terminals and pipelines, oil and gas exploration and production, and channel management and improvements.

Since impacts on sediments and geology would be confined to the proposed Project area, the only overlap that could occur would be the locations where the proposed pipelines cross existing pipelines. Onshore, ground disturbance is occurring in areas that are previously disturbed by existing industrial activities associated with the oil and gas industry.

The contribution of the proposed Project to cumulative impacts on geological resources would be short-term and minor. Permanent adverse impacts on geological resources are not expected from construction or operation of the proposed Project; therefore, the proposed Project is not expected to contribute to any potential adverse, long term, cumulative impacts on geological resources in the vicinity of the Project.

Cumulative impacts on geological resources from past, current, and foreseeable future actions in the proposed Project area would be expected from oil and gas production, installation of pipelines and structures on the OCS, dredging of shipping channels, and fishing activities.

Since alternative deepwater port designs, cooling media, anchoring systems, and compressor station designs would use the same proposed Port and DOF locations, the contribution to cumulative impacts on geological resources would be similar to the Proposed Action. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on geological resources would be similar to the Proposed Action.

6.2.5 Cultural Resources

Activities that result in disturbance of the ground and seafloor could threaten historic and prehistoric archaeological resources on and offshore. These activities include construction of deepwater ports, onshore terminals and pipelines, oil and gas exploration and production, and channel management and improvements.

There is no expected overlap of impacts on cultural resources from the proposed Project with other facilities or offshore activities.

The incremental contribution of the proposed Project to cumulative impacts on cultural resources would be short-term and minor during construction. Implementation of zones of avoidance would result in avoidance of disturbance to potential cultural resources identified during archaeological review of the geophysical and geotechnical data collected within the proposed Project area. Impacts during construction, if unanticipated discoveries occur, could result in a major incremental contribution to cumulative impacts on cultural resources. Adherence to the Unanticipated Discoveries Plan (see Appendix J) would help to reduce potential impacts. During operation, there would be no contribution to cumulative impacts on cultural resources as no new areas of seafloor would be impacted by operational activities.

Use of the fixed platform-based unit as an alternative deepwater port design may result in more widespread impacts on submerged potential cultural resources than those expected from the Proposed Action. Use of an alternative cooling media or alternative anchoring system would have similar contributions to cumulative impacts on cultural resources as the Proposed Action. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on cultural resources would be similar to the Proposed Action.

6.2.6 Ocean Use, Land Use, Recreation, and Visual Resources

Activities that could impact ocean use, land use, recreation, and/or visual resources within the vicinity of the proposed Project include construction and operation of deepwater ports; onshore terminals; BOEM's Five Year OCS Oil and Gas Program; compressor stations and pipeline systems; and channel management and improvements.

The contribution of the proposed Project to cumulative impacts on ocean use, land use, recreation, and visual resources is expected to be long-term and minor, given the overall level of activity that exists in the vicinity of the proposed Project. Additional development would result in a further reduction of unrestricted waters, potentially interfering with ocean use and recreation, and minimal additional impacts on visual resources.

Since alternative deepwater port designs, cooling media, anchoring systems, and compressor station designs would use the same proposed Port and DOF locations, the contribution to cumulative impacts on ocean use, recreation, and visual resources would be similar to the proposed action. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on land use would be similar to the proposed action.

6.2.7 Transportation

Activities that could impact transportation within the vicinity of the proposed Port include construction and operation of deepwater ports; onshore terminals; BOEM's Five Year OCS Oil and Gas Program; compressor stations and pipeline systems; and channel management and improvements. These activities could generate impacts related to navigational restrictions and increased maritime traffic and congestion.

The projects considered for cumulative analysis would use the Sabine Safety Fairway and the Calcasieu Safety Fairway so there would be a long-term and minor cumulative impact on marine transportation by adding less than one percent more vessel traffic to these fairways. It should be noted, however, that this additional traffic would be limited to the southern extremities of these fairways, well beyond the more congested waterways that are under the control of the USCG Vessel Traffic Control System.

The contribution of the proposed Project to cumulative impacts on transportation would be minor and long-term. LNGCs and service vessels associated with the proposed Project would be a small fraction of the many vessels currently transiting the Project area. Waterways in the coastal areas off the coasts of Louisiana and Texas are adapted to heavy use. Additionally, implementation of navigational safety measures, adherence to safe navigation practices established through the 1972 International Rules of the Road (Convention on the International Regulations for Preventing Collisions at Sea, 1972), and coordination with Federal and State agencies responsible for regulating marine traffic would reduce the cumulative impact on transportation.

Alternative port designs would result in negligible differences in cumulative impact on transportation. None of the different cooling media alternatives would produce different cumulative impacts on transportation. Any difference in cumulative impacts with alternative DOF locations would be very difficult to measure because the alternative locations are all close together and a great distance from the projects considered for cumulative analysis. Alternative anchoring systems would also produce a negligible difference in cumulative impacts provided that the No Anchoring Area is not increased in size. In general, the distance from the projects considered for cumulative analysis, the distance from established safety fairways, and relatively modest increase in vessel traffic to and from the proposed DOF all serve to minimize any differences in these alternatives when compared to the Proposed Action.

6.2.8 Air Quality

Activities that could impact air quality within the vicinity of the proposed Port include other offshore platform emission sources. Emissions from these sources would overlap with air quality impacts from operation of the Port. A dispersion modeling cumulative impact analysis was performed by Delfin LNG that included the emissions from nearby platform sources, and determined that air quality impacts from operation of the proposed Port would remain in compliance with all applicable air quality standards.

The proposed Port's incremental contribution to air quality impacts in the Project vicinity would be below the significant impact levels established by USEPA in its guidance for implementation of the NAAQS (USEPA 2010). Air quality impacts from construction and decommissioning of the proposed Port would be short-term, minor, and adverse. Air quality impacts from operation of the proposed Port would be long-term, minor, and adverse. Incorporation of any of the specific alternatives considered for the location or design of the Port would make a negligible difference in potential impacts on air quality.

Activities that could impact air quality within the vicinity of the proposed DOF include three nearby existing gas handling facilities. Emissions from these sources would overlap with air quality impacts from operation of the proposed DOF. A dispersion modeling analysis was performed by Delfin LNG, including cumulative impacts from nearby existing facilities from nitrogen dioxide and particulate matter less than 2.5 microns (or $PM_{2.5}$) emissions, and determined that air quality impacts from operation of the proposed DOF would remain in compliance with all applicable air quality standards. The proposed DOF's incremental contribution to air quality impacts in the Project vicinity would not be major. Air quality impacts from construction and decommissioning of the proposed DOF would be short-term, minor, and adverse. Air quality impacts from operation of the proposed DOF would be long-term, minor, and adverse. Incorporation of any of the specific alternatives considered for the location or design of the proposed DOF would make a negligible difference in potential impacts on air quality.

6.2.9 Noise

Noise-generating activities in the vicinity of the proposed Project include construction-related noise from installation of platforms, deepwater ports, and offshore pipelines; helicopter and other support vessel traffic; and deepwater port operations.

The contribution of the proposed Project to cumulative impacts on onshore noise would be minor and long-term. As part of a cumulative noise impact, baseline noise measurements determined the noise contributions from nearby gas facilities and the existing ambient conditions. The measured levels, combined with predicted acoustic impacts from the on-site facilities, indicate the cumulative acoustic effects would meet the FERC requirements for minimizing project-related noise. The PSI Cameron Meadows Gas Processing Plant has been shut down with no intention to resume operations. The Stingray Gas Plan is 5,617 feet (ft) or 1.06 mile to Noise Sensitive Area (NSA) 1. Given this distance and the type of operations at the plant, it is unlikely there would be any noise contribution from this facility at any of the NSAs. Delfin LNG proposes to install a new meter station for the proposed DOF located on the Transco Station 44 property. The location of the meter station would be approximately 2,450 ft north of the proposed DOF site center and 4,232 ft from the nearest NSA. Due to the distance between the meter station and the NSAs, and accounting for the meter station sound level design (not to exceed 85 A-weighted decibels at 3 ft), no additional noise contribution would be expected at the NSAs due to the operation of the meter station. The existing Compressor Station 44 in Cameron Parish is being upgraded with the addition of two Mars 100S turbine-driven compression units rated at 16,000 hp each (for a total of 32,000 hp) and four bays of cooling and related auxiliary equipment installed on an elevated platform with new station suction and discharge piping with a target in-service date of the first quarter of 2017. Acoustic modeling and locations of NSAs are described in Section 4.17.2. The results summarized in Table 6.2-1 indicate that the proposed DOF would be able to meet FERC's requirements for meeting project-related noise at the three nearby NSAs.

Table 6.2-1. Summary of Cumulative Noise Levels at NSAs and Expected Increase in L_{dn} above Existing L_{dn}

NSA	Existing Ambient L_{dn} (dBA)	DOF Contribution L_{dn} (dBA)	Compressor Station 44 Contribution L_{dn} (dBA)	Combined L_{dn} DOF, Station 44,and Existing Ambient (dBA)	Cumulative Expected Increase (dB)	DOF Only Expected Increase (dB)
#1	52.2	46.4	38.8	53.4	1.2	1.0
#2	65.3	50.6	41.5	65.5	0.2	0.1
#3	55.8	45.3	36.5	56.2	0.4	0.4

Key:
dBA = A-weighted decibels; DOF = Delfin Onshore Facility; L_{dn} = day-night sound level; NSA = noise sensitive area

Since alternative deepwater port designs, cooling media, anchoring systems, and compressor station designs would use the same proposed Port and DOF locations, the contribution to cumulative impacts on noise would be similar to that from the Proposed Action. Since the alternative DOF locations are adjacent to the proposed DOF location, the contribution to cumulative impacts on noise would be similar to that from the Proposed Action.

Underwater noise generated during operation of the proposed Port would have long-term adverse impacts on biological resources in the vicinity of the Port. Temporary increases in the underwater noise levels would result from use of construction vessels, and increased traffic from supply and crew vessels. Underwater operational noise from the proposed Project would include the use of thrusters to position the LNGCs and propeller cavitation while the vessel is in transit in the area. FLNGV liquefaction, LNG offloading, and other normal vessel operations would also add to the underwater noise.

Overall, the incremental contribution of the proposed Project from operational noise to the cumulative noise impacts in the offshore area would be minor compared to the existing levels of commercial, recreational, fishing, and oil and gas exploration and development traffic in the Gulf of Mexico.

6.2.10 Socioeconomics

Most of the activities included in the cumulative impacts analysis are part of the continued development of the oil, gas, and shipping industries in the vicinity of the Project; therefore, they would be expected to influence socioeconomic factors such as population, housing, employment, and tourism. The contribution of the proposed Project to cumulative impacts on socioeconomics would be long-term and minor with beneficial increases in spending, employment, and demand for local housing.

A further reduction of unrestricted waters as a result of the proposed Project and other activities listed in Tables 6.1-1 and 6.1-2 could negatively impact commercial and recreational fisheries, which are a component of the local economy. However, popular fishing locations are quite changeable and, as historic fishing grounds permeate this area of the Gulf of Mexico, fishermen can relocate to adjacent and comparable grounds with limited impact on these industries.

Additionally, environmental justice criteria were used to determine whether any racial, ethnic, or socioeconomic groups bear a disproportionate share of the adverse human health or environmental impacts resulting from the proposed Project. Ongoing development in the vicinity of the proposed Project would result in both beneficial and adverse socioeconomic impacts, including creation of new jobs and revenue for the local economy as well as increased demand for public services. However, it is not expected that any racial, ethnic, or socioeconomic group would bear a disproportionate share of any impacts, either beneficial or adverse.

Alternative deepwater port designs may employ more or less personnel, and may result in a smaller or larger restricted area around the proposed Port, during construction and operation; however, the difference in contribution to impacts on socioeconomics would likely be imperceptible. Alternative cooling media, anchoring systems, and compressor station designs would use the same proposed Port and DOF locations and would result in a similar contribution to cumulative impacts on socioeconomics. Selection of an alternative DOF location would also result in a similar contribution to impacts on socioeconomics as the Proposed Action.

7.0 COASTAL ZONE CONSISTENCY

Congress enacted the Coastal Zone Management Act (CZMA) in 1972 to encourage the preservation, protection, development, and, where possible, restoration or enhancement of valuable natural coastal resources such as wetlands, floodplains, estuaries, beaches, dunes, barrier islands, and coral reefs, as well as the fish and wildlife using those habitats. The CZMA applies to activities within the defined coastal zone, as well as activities outside of the defined coastal zone if there is the potential to impact resources within the coastal zone. Under the CZMA, coastal states have the authority to implement comprehensive coastal management programs and to conduct a consistency review for a Federal action that may have a reasonable foreseeable effect to resources contained within the State's coastal zone (15 Code of Federal Regulations [CFR] 930, 15 CFR 923). Consistency determinations are also required for activities that are Federally funded, licensed, and/or permitted, including offshore infrastructure in U.S. navigable waters, including waters in the Economic Exclusion Zone (EEZ), which might impact coastal waters.

As a condition of Deepwater Port Act (DWPA) license issuance, the proposed Project must demonstrate consistency with the coastal management program of the adjacent coastal state(s), if one has been adopted. The Louisiana State and Local Coastal Resources Management Act of 1978 authorized and required creation of the Louisiana Coastal Resources Program, which, among other activities, processes consistency determinations. The Louisiana Coastal Zone includes all or portions of nine parishes in Louisiana including Assumption, Cameron, Lafourche, St. Mary, Terrebonne, Calcasieu, Florida, Iberia, and St. Martin parishes (Louisiana House Bill 656 – Act 588). Likewise, the Texas Coastal Coordination Act of 1991 established a comprehensive coastal resource management program in Texas. The Texas Coastal Management Program (CMP) gives Texas the authority to review proposed Federal actions and activities that are located in or may affect the land and water resources in the Texas Coastal Zone through a Federal consistency review process. The Texas Coastal Zone includes all or portions of 18 counties along the Gulf of Mexico including Orange, Jefferson, Chambers, Harris, Galveston, Brazoria, Matagorda, Jackson, Victoria, Calhoun, Refugio, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Willacy, and Cameron counties (Texas Costal Coordination Act).

Should a DWPA license be issued, the Applicant would be required to obtain approvals related to the CZMA, and comply with all applicable and appropriate permits, guidelines, and approvals as provided for therein.

Concurrent with its DWPA application, Delfin LNG prepared a joint Louisiana Coastal Use Permit (CUP) /U.S. Army Corps of Engineers (USACE) application that detailed both the proposed DOF and proposed Port. This joint application was also submitted to the Louisiana Department of Natural Resources Office of Coastal Management Consistency Section for review and approval. The CUP/USACE permit and the consistency determination must be issued before the proposed Project can commence construction. On August 3, 2016, the LDNR Office of Coastal Management provided a determination that the proposed Project is consistent with the Louisiana Coastal Resources Program as required by Section 307 of the CZMA. Delfin LNG has also requested a CMP consistency determination from the Texas General Land Office (GLO). On August 7, 2015, the Texas GLO Texas Coastal Management Program provided a determination that there are no significant unresolved consistency issues with respect to the proposed Project. Correspondence with these state agencies, with respect to the CZMA, is presented in Appendix D, Agency Correspondence.

8.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

An irreversible or irretrievable commitment of resources refers to impacts on or losses to resources that cannot be reversed or recovered, even after an activity has ended and facilities have been decommissioned. A commitment of resources is related to use or destruction on nonrenewable resources, and the impacts that loss would have on future generations. For example, if a species becomes extinct or minerals are extracted as a result of the proposed Project, the loss would be permanent. Chronic, low-level pollution can injure and kill organisms at virtually all trophic levels. Mortality of individual organisms can be expected to occur, as well as the possibility of a reduction or the elimination of a few small or isolated populations. Delfin LNG LLC's (Delfin LNG) construction and operation would involve the irreversible or irretrievable commitment of material resources and energy, marine area resources, and biological resources. The impacts on these resources would be permanent.

The work required to construct and operate the proposed Project would require the conversion of available fossil fuels to energy – an irreversible commitment of fossil fuels. Additionally, the completed proposed Project would irretrievably commit finite raw materials, such as steel, although some steel used might be recyclable after decommissioning. No supplies are considered scarce, and the use of these supplies would not limit other unrelated construction activities in the region.

Delfin LNG's construction and operation would result in an irreversible or irretrievable loss of some biological resources. Irretrievable losses of seafloor habitat associated with the footprint of the disconnectable tower yoke mooring system, service vessel mooring points, and other port facilities would occur over the life of the proposed Project. Due to the removal of these features upon decommissioning, the seabottom habitat in the area would return to near-normal pre-Project conditions. Biological losses include the entrainment of fish eggs and larvae associated with ballast water intake. Associated loss of ecological services would also occur during construction and operation of the proposed Project. These services, including any commercial or recreational ocean use in the area, would recover after decommissioning of the proposed Project; however, the loss of ecological services during this period would be an irreversible or irretrievable loss of resources. Irreversible losses might also include the loss of marine animals in the event of a liquefied natural gas (LNG) spill, and loss of sea turtles or marine mammals due to ship strikes.

Although the impact on archaeological resources is expected to be minor, any interaction between an impact-producing factor (e.g., placement of new structures and laying pipelines) and a significant historic shipwreck or prehistoric site could destroy information contained in site components and their spatial distribution. This could cause a permanent loss of potentially unique archaeological data. Site selection took into account the potential for archaeological resources in the area and to minimize the potential to disturb archaeological artifacts.

Deepwater Port Act (DWPA) activities would be carried out under comprehensive, state-of-the-art, enforced regulatory procedures designed to ensure public safety and environmental protection. Nonetheless, some loss of human and animal life could result from unpredictable and unexpected acts of man and/or nature (accidents, terrorism, human error and noncompliance, and adverse weather conditions). Some normal and required operations, such as structure removal done in accordance with applicable laws and regulations, can result in the destruction of viable marine life. Although the possibility exists that individual marine mammals, sea turtles, birds, and fish could be injured or killed, these losses are unlikely to have a lasting impact on existing populations.

9.0 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

Short-term refers to the total duration of installations and at-sea construction of the proposed Port Delfin LNG Project (Project). Long-term refers to an infinite period following decommissioning of the proposed Project. Short-term operational activities might result in chronic impacts over a longer period. Installation and the eventual removal of new structures would cause minor impacts in the short-term, which would be limited to the immediate vicinity of the activity; impacts of site clearance and decommissioning might last longer because of minor elements that would be left in place. Short-term use might have long-term impacts on biologically sensitive offshore areas or archaeological resources. Upon completion of the Deepwater Port Act (DWPA) activities, the marine environment would generally be expected to remain at or return to its normal long-term productivity levels.

The proposed Project would be located in the Gulf of Mexico, approximately 37.4 to 40.8 nautical miles off the coast of Louisiana, in a region that is populated with oil and gas platforms, drilling rigs, and aids to navigation. This area supports the oil and gas industry, marine commerce and shipping, commercial and recreational fishing, area ports, and other uses. Construction of the proposed Project should have no impact on long-term productivity of the continental shelf because this area is already heavily trafficked.

No long-term productivity or environmental gains are expected as a result of the DWPA development of the Gulf of Mexico. Benefits of the proposed Project are expected to be principally those associated with an increase in supplies of natural gas for export. While no reliable data exist to indicate long-term productivity losses as a result of the use of the proposed Project area, such losses are possible.

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