Application for Incidental Harassment Authorization and Letter of Authorization for the Non-Lethal Taking of Marine Mammals - Port Dolphin Energy LLC Deepwater Port

Revised

28 January 2011

Submitted to:

Office of Protected Resources
National Marine Fisheries Service
1315 East-West Highway
Silver Spring, Maryland 20910-3226

Submitted by:

Port Dolphin Energy LLC
400 North Tampa Street, Suite 1015
Tampa, Florida 33602
(813) 514-1398

Prepared by:

CSA International, Inc.
8502 SW Kansas Avenue
Stuart, Florida 34997
(772) 219-3000

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List of Abbreviations

CETAP	Cetacean and Turtle Assessment Program
CFR	Code of Federal Regulations
dB	decibel(s)
DEIS	Draft Environmental Impact Statement
DSV	diving spread vessels
DWP	Deepwater Port
EIR	Environmental Impact Report
EIS	Environmental Impact Statement
ESA	Endangered Species Act
fath	fathom(s)
FEIS	Final Environmental Impact Statement
FWC	Florida Fish and Wildlife Commission
HDD	horizontal directional drilling
hp	horsepower
Hz	Hertz
IHA	Incidental Harassment Authorization
kHz	kilohertz
km	kilometer(s)
LNG	liquefied natural gas
LOA	Letter of Authorization
M	meter(s)
MARAD	Maritime Administration
mg/L	milligram(s) per liter
MMO	Marine Mammal Observer
MMPA	Marine Mammal Protection Act
mmscfd	million standard cubic feet per day
MRA	Marine Resources Assessment
nm	nautical mile(s)
NMFS	National Marine Fisheries Service
NOAA	National Oceanic and Atmospheric Administration
OCS	Outer Continental Shelf
OPR	Office of Protected Resources
PAM	passive acoustic monitoring
PLEM	pipeline end manifold
PBR	potential biological removal
PSO	protected species observers
RMS	root mean square
ROD	Record of Decision
ROV	Remotely Operated Vehicle
SPL	sound pressure level
SPUE	sightings per unit effort
SRV	shuttle regasification vessel
STL	submerged turret loading
TECO	Tampa Electric Company
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service
ZOI	Zone of Influence

Summary

Port Dolphin Energy LLC is petitioning the National Marine Fisheries Service (NMFS) to issue an Incidental Harassment Authorization (IHA) and a Letter of Authorization (LOA) for the proposed Port Dolphin Deepwater Port (the Port). A 1-year IHA is sought for the initial phases of Port Dolphin's period of construction in 2012. Because construction will not be completed before the expiration of the initial IHA, Port Dolphin Energy LLC also requests that this application serve as the basis for issuance of a follow-on LOA to authorize non-lethal incidental takes by harassment during completion of construction activities in 2013 and for subsequent Port operations to be conducted following completion of port construction and installation activities.

The U.S. Coast Guard (USCG) and the U.S. Maritime Administration, as lead Federal agencies in the National Environmental Policy Act (NEPA) review of the Port project, issued a Draft Environmental Impact Statement (DEIS) on the Port project on April 18, 2008 and a Final EIS (FEIS) on July 9, 2009. NMFS participated in the NEPA process several times, including providing guidance (consultation) during development of the DEIS and commenting on the FEIS. In a letter to the USCG dated May 29, 2008 that summarized their review comments on the DEIS, NMFS identified the need of Port Dolphin to obtain an IHA for two protected marine mammal species under their purview – the bottlenose dolphin and the Atlantic spotted dolphin.

As required under the NMFS letter dated May 29, 2008, this IHA/LOA is being requested pursuant to Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and 50 Code of Federal Regulations (CFR) § 216 Subpart I. The IHA/LOA request is seeking approval for the incidental harassment of a small number of marine mammals resulting from the construction and operation of the Port. No Level A take (i.e., injury) is expected from Port Dolphin construction activities or Port operations. Port Dolphin sound sources are expected to produce Level B harassment (i.e., behavioral disruption) on the Atlantic spotted dolphin and bottlenose dolphin species potentially located in the project area.

The proposed Port Dolphin Deepwater Port will be an offshore liquefied natural gas (LNG) facility located approximately 45 kilometers (28 miles) off the western coast of Florida and approximately 68 kilometers (42 miles) from Port Manatee, Manatee County, Florida. Water depth at the port is 30.5 m (100 ft). Port facilities will include two submerged turret loading (STL) buoys, pipeline end manifolds (PLEM), and a natural gas pipeline to shore (**Figure S-1**). The proposed Port would consist principally of a permanently moored buoy system (i.e., two STL buoys) separated by approximately 3.1 miles. The STL buoys would be secured by eight mooring lines attached to anchor points on the seabed, flexible risers, and subsea flowlines leading to a single proposed new 36-inch natural gas transmission pipeline. This new 36-inch natural gas transmission pipeline would interconnect to the existing Gulfstream Natural Gas System, LLC (Gulfstream) transmission pipeline and and/or the Tampa Electric Company/Peoples Gas intrastate gas transmission line located in Manatee County, Florida.

This IHA request considers two aspects of the Port Dolphin Deepwater Port project: 1) construction and installation activities, projected to occur in the field over an 11-month period beginning in summer 2012; and 2) routine operations of the Port beginning in the third quarter of 2013, with an expected operational life expectancy of 25 years. A projected schedule for construction and installation activities is provided in **Table S-1**.

Figure S-1 Location of Port Dolphin Deepwater Port and Associated Pipeline to Shore

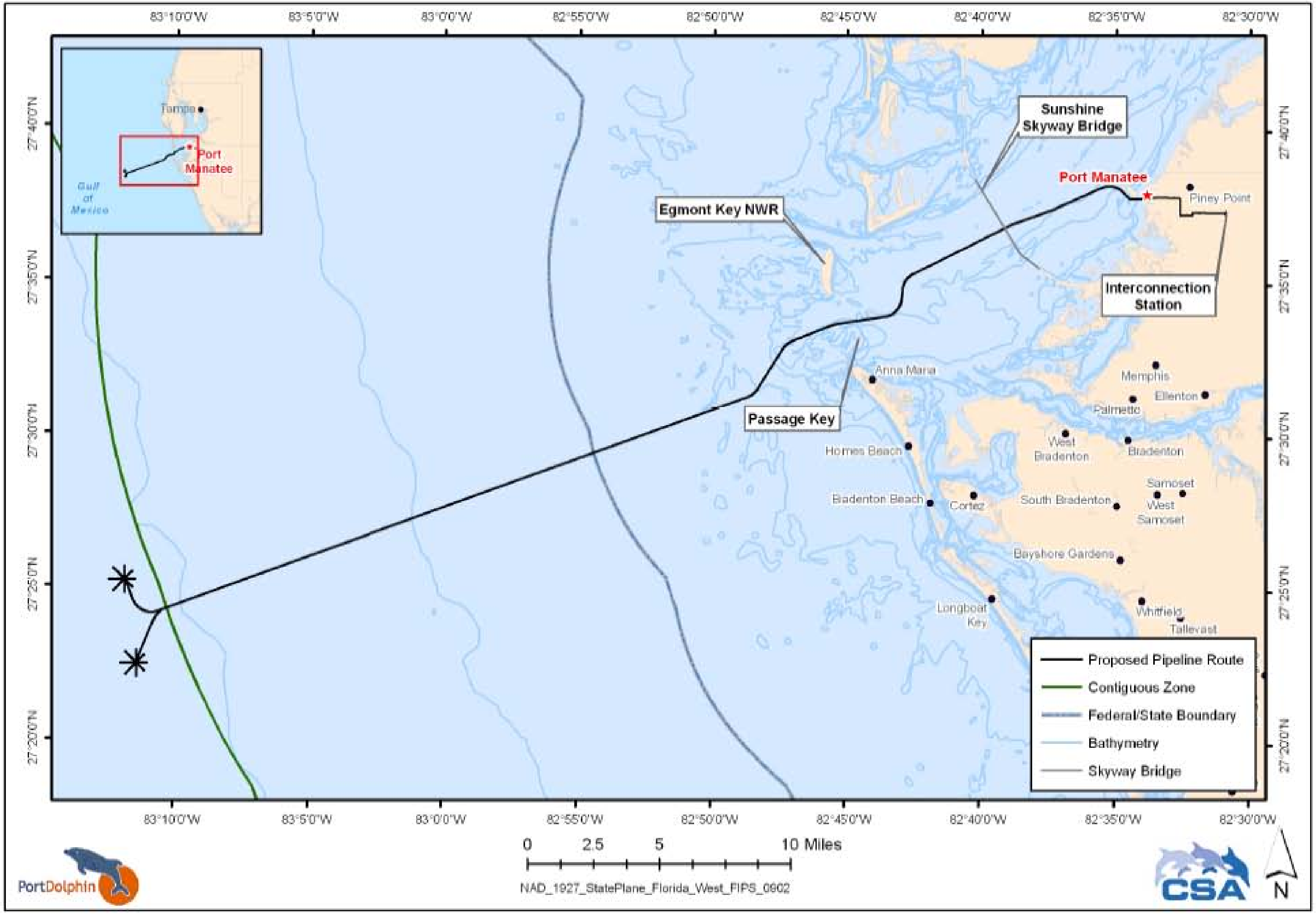


Table S-1 Projected Schedule for Construction and Installation Activities, Port Dolphin Deepwater Port

Construction and Installation Activity	Month 1				Month 2				Month 3				Month 4				Month 5				Month 6				Month 7				Month 8				Month 9				Month 10				Month 11			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Shore Approach HDD																																												
Gulfstream P/L HDD Crossing - West																																												
Gulfstream P/L HDD Crossing - East																																												
Specialty Construction Areas:																																												
Skyway Bridge Crossing																																												
Flotation Ditch																																												
Lay Pipeline:																																												
Transmission Pipeline																																												
North Flowline																																												
South Flowline																																												
Final Tie-ins																																												
Filling, Testing, and Dewatering																																												
Pipeline Burial/Covering:																																												
Plowing																																												
Install Mattresses																																												
STL Buoy Installation																																												
Impact Hammering																																												
Projected Season	Summer											Fall												Winter												Spring								

Notes:

a) Construction is continuous from mobilization to demobilization (i.e., no work stoppages due to weather or environmental issues).
b) Port Dolphin will utilize the same barge to lay and bury (plow) the pipeline.
c) Passage Key is currently assumed to be a conventional lay and bury; HDD remains an option.
d) The schedule is presented as a conservative approach (i.e., most disturbance and turbidity) with field work expected to commence July 2012.

This analysis utilized a synthesis of aerial and shipboard survey data to characterize marine mammal species presence and distribution within the Port project area. Seasonal categories included in the analysis were as follows:

- Winter: December 21 through March 20;
- Spring: March 21 through June 20;
- Summer: June 21 through September 20; and
- Fall: September 21 through December 20.

The following water depth categories, or depth strata, were considered in this analysis: 1) nearshore: 0 to 20 fath or 0 to 120 feet (0 to 36.6 meters); 2) mid-shelf: 20 to 50 fath or 120 to 300 feet (36.6 to 91.4 meters); 3) shelf-edge: 50 to 1,100 fath or 300 to 6,600 feet (91.4 to 2,000 meters); and 4) slope: >1,100 fath or >6,600 feet (>2,000 meters). Port installation and construction activities and Port operations will occur in the nearshore depth stratum (0 to 36.6 meters), although the potential for attenuation of project-related sound into adjacent depth strata was also evaluated.

This IHA/LOA application applies noise exposure criteria currently being utilized by the National Marine Fisheries Service (NMFS), Office of Protected Resources (OPR), as applicable to cetaceans. For continuous and intermittent sound sources, the Level A (injury) and Level B (behavioral disruption) thresholds are 180- and 120-dB re 1 µPa root mean square (RMS), respectively. Impulsive noise may also occur, in limited circumstances, during construction and installation; the Level A and Level B thresholds for impulsive noise are 180- and 160-dB re 1 µPa RMS, respectively.

Though several noise sources exceed the Level A sound exposure threshold, no Level A take (i.e., injury) is expected from Port Dolphin construction activities and Port operations due to the limited radial distances that the sound would travel before falling below the Level A threshold and the relatively low densities for the two dolphin species at risk. Results of this analysis indicate that the impact of construction and operation of the Port may result, at worst, in a temporary modification in behavior (i.e., Level B take) of a small number of certain marine mammal species that may be in close proximity to the Port and associated pipeline during its construction and subsequent operation. These activities are expected to result in some local short-term displacement, resulting in no more than a negligible impact on the affected species or stocks of marine mammals.

Four of the eight construction and installation activities are scheduled to occur within a single season. Level B take (i.e., potential behavioral modification) estimates for these activities include:

- Buoy Installation: scheduled to occur during summer 2012; 6 individuals taken (2 Atlantic spotted; 4 bottlenose);
- Offshore Hammering: scheduled to occur during summer 2012; 7 individuals taken (2 Atlantic spotted; 5 bottlenose);
- HDD Drilling: scheduled to occur during summer 2012; 0 individuals taken; and
- HDD Vibratory: scheduled to occur during summer 2012; 54 individuals taken (13 Atlantic spotted; 41 bottlenose).

The window for four of the remaining construction and installation activities (i.e., offshore pipeline laying, inshore pipeline laying, offshore plowing, and inshore plowing) extends across portions of two or three seasons, although each activity is expected to be completed within a single season. Given this scheduling uncertainty, Level B takes estimates have been calculated by activity as follows:

- Pipeline Laying Offshore: Scheduled to occur during either late summer or fall 2012, or early winter 2012-2013
  - 19 individuals taken in summer (4 Atlantic spotted; 15 bottlenose), or
  - 66 individuals taken in fall (19 Atlantic spotted; 47 bottlenose), or
  - 23 individuals taken in winter (4 Atlantic spotted; 19 bottlenose).
- Pipeline Laying Inshore: Scheduled to occur during either late summer or fall 2012, or early winter 2012-2013
  - 12 individuals taken in summer (3 Atlantic spotted; 9 bottlenose), or
  - 42 individuals taken in fall (12 Atlantic spotted; 30 bottlenose), or
  - 15 individuals taken in winter (3 Atlantic spotted; 12 bottlenose).
- Offshore Plowing: Scheduled to occur during either fall 2012 or winter 2012-2013
  - 83 individuals taken in fall (24 Atlantic spotted; 59 bottlenose); or
  - 29 individuals taken in winter (5 Atlantic spotted; 24 bottlenose)
- Inshore Plowing: Scheduled to occur during either fall 2012 or winter 2012-2013
  - 53 individuals taken in fall (15 Atlantic spotted; 38 bottlenose), or
  - 18 individuals taken in winter (3 Atlantic spotted; 15 bottlenose).

Given the scheduling uncertainty, Level B take estimates by season can be summarized as follows:

- Fall season: If inshore and offshore pipelaying and inshore and offshore plowing activities are all completed during the fall, these activities may cause behavioral disruption to as many as 70 Atlantic spotted dolphins and 174 bottlenose dolphins, or total of 244 individuals.
- Winter season: If inshore and offshore pipelaying and inshore and offshore plowing activities are all completed during the winter, these activities may cause behavioral disruption to as many as 15 Atlantic spotted dolphins and 70 bottlenose dolphins, or a total of 85 individuals.
- Spring season: No construction or installation activities are expected; no incidental take is predicted for this season.
- Summer season: If offshore and inshore pipeline installation activities are all completed during the summer, when coupled with offshore hammering, buoy installation, and horizontal directional drilling (HDD) vibratory driving, a total of 24 Atlantic spotted dolphins and 74 bottlenose dolphins may realize behavioral disruption, or a total of 98 individuals.

Sounds from Port Dolphin operations will include shuttle regasification vessel (SRV) maneuvering and docking, and regasification. Ensonification from port operations will be limited to the nearshore depth stratum. Atlantic spotted and bottlenose dolphins will realize the greatest numbers of Level B incidental take (potential behavioral modification).

No Level A take is expected from regasification operations. A very low Level B take is expected as a result of regasification operations. The SRV maneuvering and docking activities will not result in Level A take, but are expected to produce Level B behavioral modification to several Atlantic spotted and bottlenose dolphins. During the first year of operation beginning the third quarter of 2013, Port Dolphin expects to process 400 million billion cubic feet (bcf) of natural gas, with an expected total of 46 SRV visits. SRV visitation is expected to include the following:

- Winter and summer: 12 visits per season; and
- Spring and fall: 11 visits per season.

Level B incidental take (i.e., potential behavioral modification) estimates for annual Port Dolphin operations can be summarized as follows:

- SRV Maneuvering and Docking
  - A maximum of 878 marine mammals are expected to realize potential behavioral modification during the year associated with SRV maneuvering and docking at Port Dolphin, with lower numbers expected during those periods where full thruster output is not required;
  - Bottlenose dolphin are expected to realize higher take numbers, with 632 individuals expected to experience behavioral modification; and
  - Atlantic spotted dolphin are expected to experience lower take numbers, with 246 individuals expected to experience behavioral modification.
- Ragasification
  - A maximum of one bottlenose dolphin is expected to realize potential behavioral modification during the year as a result of regasification operations.

Loss or modification of marine mammal habitat could arise from alteration of benthic habitat, degradation of water quality, and effects of noise. These impacts could be short- or long-term in nature. No significant short-term or long-term impacts on marine mammals or their habitat were noted during the environmental analysis.

The regulations set forth in Section 101(a)(5) of the MMPA and 50 CFR § 216 Subpart I allow for the incidental taking of marine mammals by a specific activity if the activity is found to have a negligible impact on the species or stock(s) of marine mammals and will not result in adverse impact on the availability of the marine mammal species or stock(s) for certain subsistence uses that cannot be mitigated. As the Applicant, Port Dolphin Energy LLC submits this request for an IHA and LOA to authorize non-lethal incidental takes by harassment during the construction and operation of the Port and associated pipeline system in accordance with the guidance under 50 CFR Part 216 Subpart I (216.101-21.106). Section 216.104 presents 14 specific items that must be addressed in requests for rulemaking and renewal of regulations pursuant to Section 101(a)(5) of the MMPA. Each of these items is addressed in detail in the following request.

1.0 Description of the Activities

1.1 GENERAL DESCRIPTION OF ACTIVITIES

This section addresses the National Marine Fisheries Service (NMFS) Incidental Harassment Authorization (IHA)/Letter of Authorization (LOA) requirement to provide a detailed description of the specific activity or class of activities that can be expected to result in incidental taking of marine mammals. The following characterization considers construction activities (i.e., installation and construction) and port operations (i.e., berthing and regasification). Construction and installation activities are projected to occur in the field over an 11-month period. Routine operations of the Port are expected to occur over a 25-year period.

Construction and installation activities will include two major activities. These activities are:

1) installation of deepwater port (DWP) facilities, including associated flowlines; and
2) installation of a pipeline to shore.

The installation of the DWP facilities will include the construction and installation of offshore buoys, mooring lines, and anchors. The installation of the pipeline from the DWP to the shore will include burial of the pipeline, selective placement of protective cover (either boulders or concrete mattresses) over the pipeline at several locations along the pipeline route, and the horizontal directional drilling (HDD) of three segments of the pipeline.

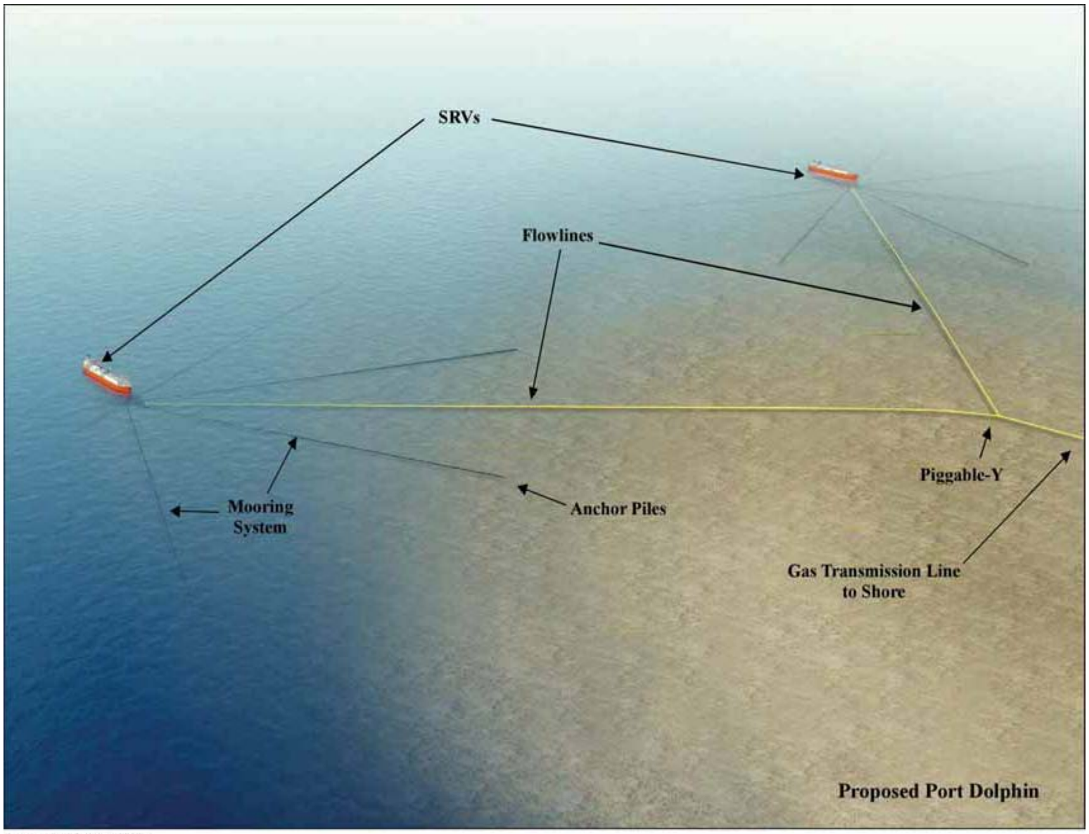
The Port Dolphin DWP would be capable of mooring shuttle and regasification vessels (SRVs). SRVs are designed to carry liquefied natural gas (LNG) combined with a capability to regasify the natural gas prior to off-loading for transport to shore. Two unloading buoys, also known as submerged turret loading (STL) buoys, would be separated by a distance of approximately 3.1 miles (5 kilometers). Each STL buoy would moor one SRV on location throughout the unloading cycle (**Figure 1-1**).

Each STL buoy would have eight mooring lines consisting of wire rope and chain. The mooring lines would connect each STL buoy to eight anchor points, most likely consisting of piles driven into the seabed. When not connected to a SRV, the STL buoy would be submerged 60 to 70 feet (18 to 21 meters) below the sea surface.

An SRV would typically moor at the deepwater port for between 4 and 8 days, depending on vessel size and send-out rate. Unloading of natural gas (i.e., vaporization or regasification) would occur through the flexible riser and into the pipeline end manifold (PLEM) for transportation to shore via the subsea pipeline. The two separate STL buoys would allow natural gas to be delivered in a continuous flow, without interruption, by Port Dolphin scheduling an overlap between arriving and departing SRVs.

Based on a regasification cycle of approximately 8 days and initial throughput of 400 million bcf, vessel traffic during operations is projected to consist of 46 SRV unloadings per year during the first several years of operation. In the open ocean, SRVs typically travel at speeds of up to 19.5 knots. However, once approaching the vicinity of the DWP, the SRVs would typically slow to about half speed (i.e., during approach to the DWP). In close proximity to the STL buoys, the SRVs would utilize thrusters to attain proper vessel orientation relative to the DWP, taking into consideration ambient ocean current and wind conditions and buoy position.

Figure 1-1 Conceptual Site Plan, Port Dolphin Deepwater Port



Source: Port Dolphin 2007a

Initially, it is expected that the average daily throughput of the port will be approximately 400 million standard cubic feet per day (mmscfd). When fully operational, Port Dolphin would be capable of achieving an average throughput of 800 mmscfd and a peak capacity of approximately 1,200 mmscfd; however it is not anticipated that during the initial several years of Port operations that the average daily throughput would increase above the 400 mmscfd. Natural gas would be sent out by means of a 16-inch flexible riser from each buoy down to two 36-inch subsea flowlines through a piggable-Y to a 36-inch gas transmission line. The gas transmission line would transport natural gas to onshore facilities for interconnection with the Gulfstream Natural Gas System and Tampa Electric Company (TECO) pipeline system.

1.2 CONSTRUCTION AND INSTALLATION ACTIVITIES

Construction of Port Dolphin would proceed in two phases and last a total of approximately 22 months, with the DWP expected to commence operations in the third quarter of 2013. The first phase of construction and installation would consist of the offsite fabrication of major components, including the STL buoys and associated equipment and marine piping. No incidental take of marine mammals is expected from the first phase.

The second phase, lasting approximately 11 months in the field, would consist of siting the STL buoys and associated equipment and laying the marine pipeline. It is anticipated that the installation effort encompassing the second phase would be accomplished in the following sequence: HDD construction and installation inshore; PLEM installation, anchor installation (including pile driving), and STL buoy installation; dredging and pipeline installation in the vicinity of the Skyway Bridge; and complete pipeline and flowline installation offshore and pipeline testing.

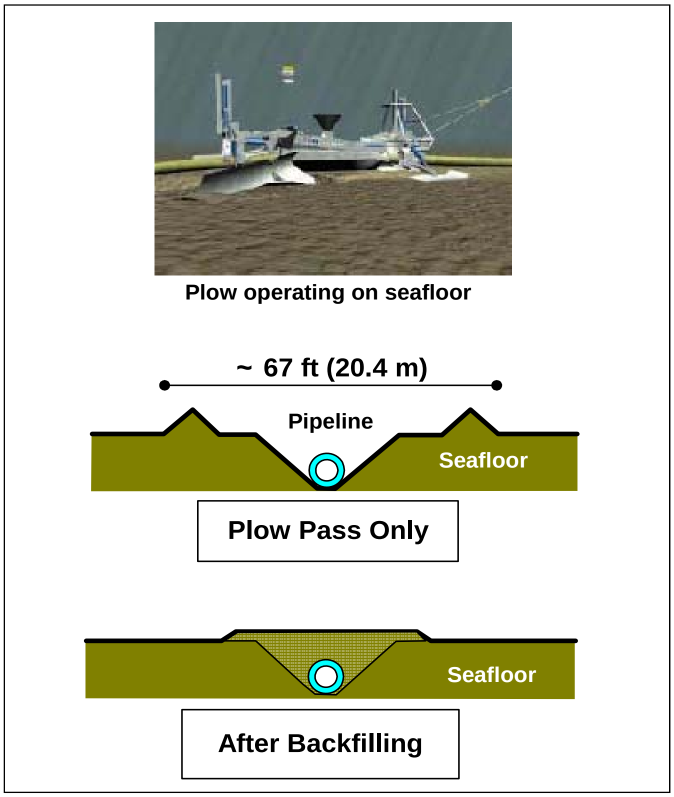
1.2.1 Installation at the STL Buoys

Offshore installation activities at the Port Dolphin DWP will begin with installation of the PLEMs at both the north and south STL buoy locations, followed by placement of the buoy anchors, mooring lines, buoys, and risers. Installation activities at both STL buoy locations will require a cargo barge, supported by anchor-handling support vessels, a supply boat, a crew transfer boat, and a tug. Anchor installation may require pile driving (impact hammering).

1.2.2 Pipeline Installation

The pipeline will be laid on the seafloor by a pipelaying barge and then buried, typically using a plowing technique. Other techniques, such as dredging and HDD, is planned to be used in certain areas depending on the final geotechnical survey, engineering considerations, and equipment selection. Under the plowing method, the pipeline is lowered below seabed level by shearing a "V"-shaped ditch underneath it. The plow is towed along and underneath the pipeline by the burial barge. As the ditch is cut, sediment is removed and passively pushed to the side by specially shaped moldboards that are fitted to the main plowshare. Then the trench is backfilled with a subsequent pass of the plow. The estimated width of the trench (including sediments initially pushed to each side) is 67 feet (20.4 meters) (**Figure 1-2**).

Figure 1-2 Photograph and Diagram of Plowing for Pipeline Burial



In areas that cannot be plowed (e.g., due to hard/live bottom) or complete burial cannot be achieved, the pipeline will be covered with an external cover (e.g., concrete mattresses or rock armoring).

Although plowing is the preferred methodology for pipeline burial, other techniques such as dredging and HDD will be used in certain areas. The total length of the pipeline for the pipeline route is 74,174 meters. The total length of pipeline, excluding HDD segments, is 71,780 meters. Burial techniques to be used along the pipeline route and their relative lengths are characterized as follows:

- Plowing/trenching soft sediments: 39,633 meters (53.2% of total pipeline length);
- Plowing/external cover: 23,323 meters (31.4% of total pipeline length);
- External cover (concrete mattress/rock armoring): 8,505 meters (11.7% of total pipeline length);
- Clamshell dredging/dragline burial: 337 meters (0.5% of total pipeline length); and
- HDD: 2,394 meters (3.2% of total pipeline length).

Clam shell dredging will be performed from a fixed working platform (e.g., spud barge or jack-up barge). In the area near Manbirdtee Key, a floatation ditch will be dredged using conventional dredging equipment (i.e., the same barge that will be used to pull-in the shore approach HDD). The anticipated locations of pipeline burial or armoring activities are shown in **Figure 1-3**.

1.2.3 HDD and Use of “Goal Posts”

HDD will be employed for installation of the Port Dolphin pipeline at three locations along the inshore portion of the route. The proposed HDD locations are drilling from land to water at the Port Manatee shore approach and from water-to-water at two crossings of the Gulfstream pipeline. Port Dolphin has also identified the need to install “goal posts” as part of the HDD drilling effort at the two water-to-water HDD locations, to hold the HDD strings while pulling into the HDD holes. One potential option is that the goal posts are designed to self install; however, another option is that drilling may be required. Further, at the shore-to-water transition HDD, Port Dolphin will have to install sheet piling to form a coffer dam, designed to contain the HDD exit pit so as to not impact nearby seagrasses. Sheet pile segments will be installed by vibratory means.

1.2.4 Construction Vessels

Table 1-1 details the vessels that would be used during the DWP and pipeline construction and installation activities. The projected duration and duty load of each vessel are also provided. Duty load is a primary consideration when characterizing project-related noise sources.

Figure 1-3 Anticipated Locations of Port Dolphin Pipeline Installation Activities

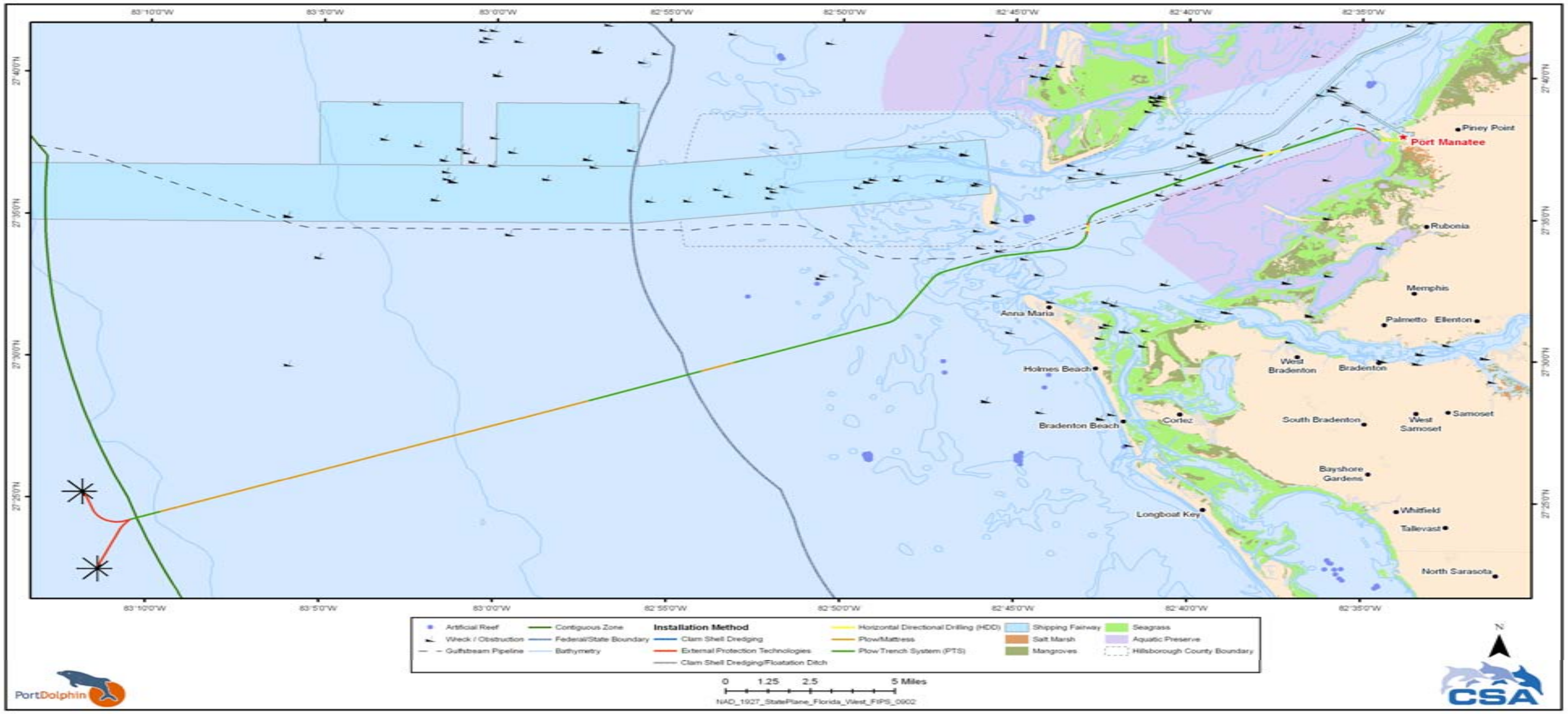


Table 1-1 Vessels to be Employed During Port Dolphin Construction and/or Facility Installation Operations (Adapted from: JASCO, 2008, 2010)

<table>
<tr><th>Operation</th><th>Auxiliary Equipment/Comments</th><th>Engine Specifications</th><th>Operational Usage</th></tr>
<tr><td colspan="4">Construction/Installation at Offshore Facility (DWP)</td></tr>
<tr><td>Barge</td><td>--</td><td>No propulsion</td><td rowspan="5">24 hours/day; 3.5 months at 100% load</td></tr>
<tr><td>Anchor-Handling Support Vessels</td><td>ROV winches, hydraulic pumps, thrusters, sonar, survey equipment</td><td>Two 3,750-hp diesel engines</td></tr>
<tr><td>Supply Boat</td><td>Bow thruster</td><td>671-hp diesel engine</td></tr>
<tr><td>Crew Transfer Boat</td><td>--</td><td>671-hp diesel engine</td></tr>
<tr><td>Tug</td><td>--</td><td>800-hp diesel engine</td></tr>
<tr><td>Impact Hammer</td><td>--</td><td>--</td><td>As required</td></tr>
<tr><td colspan="4">Pipeline Installation</td></tr>
<tr><td>Jackup: Port Manatee HDD</td><td>Diesel Engine</td><td>3,000-hp diesel engine</td><td>24 hours/day; 27 days at 50% load</td></tr>
<tr><td rowspan="2">Spud Lay Barge: Shallow lay barge operation. Barge has no propulsion. Two tugs are used</td><td>Tug</td><td>1,200-hp diesel engine</td><td>24 hours/day; 59.4 days at 75% load</td></tr>
<tr><td>Tug</td><td>1,200-hp diesel engine</td><td>24 hours/day; 59.4 days at 75% load</td></tr>
<tr><td rowspan="2">East Jackups</td><td>Jackup</td><td>3,000-hp diesel engine</td><td>24 hours/day; 27 days at 75% load</td></tr>
<tr><td>Jackup</td><td>3,000-hp diesel engine</td><td>24 hours/day; 27 days at 75% load</td></tr>
<tr><td rowspan="2">West Jackups</td><td>Jackup</td><td>3,000-hp diesel engine</td><td>24 hours/day; 27 days at 75% load</td></tr>
<tr><td>Jackup</td><td>3,000-hp diesel engine</td><td>24 hours/day; 27 days at 75% load</td></tr>
<tr><td rowspan="2">Pipelay Barge: Large lay barge pipeline operation. Barge has no propulsion. Uses two tugs</td><td>Tug</td><td>2,000-hp diesel engine</td><td>24 hours/day; 37 days at 85% load</td></tr>
<tr><td>Tug</td><td>2,000-hp diesel engine</td><td>24 hours/day; 37 days at 85% load</td></tr>
<tr><td>Dragline Barge</td><td>Barge</td><td>600-hp diesel engine</td><td>24 hours/day; 6 days at 100% load</td></tr>
<tr><td rowspan="2">Plow Lay Barge: Plow burial of pipeline. Barge has no propulsion. Uses two tugs</td><td>Tug</td><td>2,000-hp diesel engine</td><td>24 hours/day; 113 days at 85% load</td></tr>
<tr><td>Tug</td><td>2,000-hp diesel engine</td><td>24 hours/day; 113 days at 85% load</td></tr>
<tr><td rowspan="2">4-Pt DSVs for two supply vessels: Mattress armoring</td><td>Vessel</td><td>1,000-hp diesel engine</td><td>24 hours/day; 108 days at 100% load</td></tr>
<tr><td>Vessel</td><td>1,000-hp diesel engine</td><td>24 hours/day; 108 days at 100% load</td></tr>
<tr><td rowspan="4">4-Pt DSVs for two supply vessels: Mattress armoring</td><td rowspan="2">Vessel</td><td>1,000-hp diesel engine</td><td>24 hours/day; 12 days at 15% load</td></tr>
<tr><td>1,000-hp diesel engine</td><td>24 hours/day; 12 days at 15% load</td></tr>
<tr><td rowspan="2">Vessel</td><td>1,000-hp diesel engine</td><td>24 hours/day; 12 days at 15% load</td></tr>
<tr><td>1,000-hp diesel engine</td><td>24 hours/day; 12 days at 15% load</td></tr>
<tr><td rowspan="4">Vessel: Gauge, fill, test, dewater and drying operations</td><td rowspan="2">Vessel</td><td>300-hp diesel engine</td><td>24 hours/day; 13 days at 35% load</td></tr>
<tr><td>300-hp diesel engine</td><td>24 hours/day; 13 days at 35% load</td></tr>
<tr><td rowspan="2">Vessel</td><td>300-hp diesel engine</td><td>24 hours/day; 13 days at 35% load</td></tr>
<tr><td>300-hp diesel engine</td><td>24 hours/day; 13 days at 35% load</td></tr>
</table>

Table 1-1 (Continued)

Operation	Auxiliary Equipment/Comments	Engine Specifications	Operational Usage
Survey vessel	Vessel	1,000-hp diesel engine	24 hours/day; 54 days at 50% load
	Vessel	1,000-hp diesel engine	24 hours/day; 54 days at 50% load
Spud Lay Barge: Shallow lay barge operation. Barge has no propulsion. Two tugs are used	Tug	1,200-hp diesel engine	24 hours/day; 6.6 days at 15% load
	Tug	1,200-hp diesel engine	24 hours/day; 6.6 days at 15% load
East Jackups	Jackup	2,000-hp diesel engine	24 hours/day; 3 days at 15% load
	Jackup	2,000-hp diesel engine	24 hours/day; 3 days at 15% load
West Jackups	Jackup	2,000-hp diesel engine	24 hours/day; 3 days at 15% load
	Jackup	2,000-hp diesel engine	24 hours/day; 3 days at 15% load
Pipelay Barge: Large lay barge pipeline operation. Barge has no propulsion. Uses two tugs	Tug	2,000-hp diesel engine	24 hours/day; 4 days at 15% load
	Tug	2,000-hp diesel engine	24 hours/day; 4 days at 15% load
Dragline Barge	Barge	600-hp diesel engine	24 hours/day; 1 day at 15% load
Plow Lay Barge: Plow burial of pipeline. Barge has no propulsion. Uses two tugs	Tug	2,000-hp diesel engine	24 hours/day; 13 days at 15% load
	Tug	2,000-hp diesel engine	24 hours/day; 13 days at 15% load
4 Pt DSVs for two supply vessels: Mattress armoring	Vessel	1,000-hp diesel engine	24 hours/day; 12 days at 15% load
		1,000-hp diesel engine	24 hours/day; 12 days at 15% load
	Vessel	1,000-hp diesel engine	24 hours/day; 12 days at 15% load
		1,000-hp diesel engine	24 hours/day; 12 days at 15% load
Vessel: Gauge, fill, test, dewater, and drying operations	Vessel	300-hp diesel engine	24 hours/day; 1 day at 15% load
		300-hp diesel engine	24 hours/day; 1 day at 15% load
	Vessel	300-hp diesel engine	24 hours/day; 1 day at 15% load
		300-hp diesel engine	24 hours/day; 1 day at 15% load
Survey Vessel	Vessel	1,000-hp diesel engine	24 hours/day; 6 days at 15% load
Dredge	--	--	
HDD Operations			
Jackup: Port Manatee HDD Operation	Jackup	3,000-hp diesel engine	24 hours/day; 3 days at 15% load
Floating Spud Barge. Barge has no propulsion. Two tugs are used	Barge	Crane-mounted drill and vibratory drill; ancillary equipment includes welding equipment, air compressor, and generator	24 hours/day; maximum 4 days for vibratory drilling at each HDD location
Tugs	--	800-hp diesel engine	24 hours/day; maximum 4 days for vibratory drilling at each HDD location

DSV =diving spread vessels; DWP = Deepwater Port; HDD = horizontal directional drilling; ROV = remotely operated vehicle.

1.2.5 Sounds from Construction and Installation Activities

This analysis applies noise exposure criteria currently being utilized by NMFS, Office of Protected Resources (OPR). For continuous and intermittent sound sources, the Level A (injury) and Level B (behavioral disruption) thresholds are 180- and 120-dB re 1 µPa root mean square (RMS), respectively. Impulsive noise may also occur in limited circumstances during construction and installation; the Level A and Level B thresholds for impulsive noise are 180- and 160-dB re 1 µPa RMS, respectively.

During construction, underwater noise would be created by construction vessels (e.g., barges, tugboats, and supply/service vessels) and machinery (e.g., pile-driving and pipe-laying equipment, trenching equipment, and "goal post" installation equipment at the HDD locations) operating either intermittently or continuously throughout the area during the construction period. Vessel traffic associated with construction would be a relatively continuous noise source during that period. **Table 1-1** details the anticipated vessels that would be used during the DWP and pipeline construction. Vessel noise, which is transmitted through air and water, would be created by propulsion machinery, thrusters, generators, and hull vibrations and would vary with ship and engine size. Machinery noise from underwater construction would be transmitted through water and would vary in duration and intensity. Port construction (i.e., field construction and installation operations) would require approximately 11 months.

Sound propagation modeling was performed to predict the radii of noise impacts from construction and operational activities. The sound propagation model used several parameters, including expected water column sound speeds, bathymetry (water depth and shape of the ocean bottom), and bottom geoacoustic properties (how much noise is reflected off of the ocean bottom), to estimate the radii of noise impacts (JASCO, 2008). The maximum and broadband source levels for vessel and facility sources characterized in the noise analysis are outlined in **Table 1-2**. Complete third-octave band source levels over frequencies ranging from 10 Hz through 2,000 Hz (or 10 Hz through 5,000 Hz for drilling and HDD-associated vibratory driving), as employed in the noise modeling, are presented in **Appendix A**.

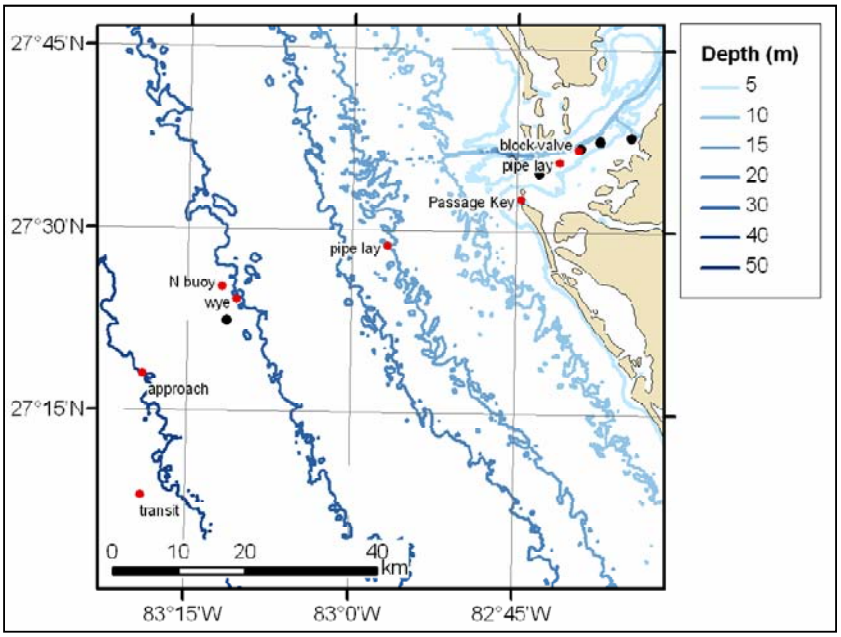
Table 1-2 Source Levels from Construction/Installation Operations at the Port Dolphin DWP (Adapted from: JASCO, 2008, 2010)

Vessel or Source	Activity	Location	Source Levels (dB re 1µPa)
Barge	Anchor installation operations	STL buoys (DWP site offshore)	Maximum: 175.6 dB @ 10 Hz Broadband: 177.2 dB
Tug	Anchor installation operations	STL buoys (DWP site offshore)	Maximum: 196.7 dB @ 25 Hz Broadband: 205.2 dB
Impact Hammer	Pile driving, anchor installation operations	STL buoys (DWP site offshore)	Maximum: 209.5 dB @ 200 Hz Broadband: 216.5 dB
Barge	Pipelaying	Along pipeline corridor, from the DWP location to shore	Maximum: 169.0 dB @25 Hz Broadband: 173.9 dB
Tug	In transit	Offshore and inshore	Maximum: 188.7 dB @ 10 Hz Broadband: 190.8 dB
Dredge	Dredging	Variable, offshore and inshore, as needed	Maximum: 180 dB @ 160 Hz Broadband: 187.7 dB
HDD	HDD drilling	Two locations within Tampa Bay	Maximum: 154.0 dB @250 Hz Broadband: 156.9 dB
Vibratory Driving	Vibratory sheet pile installation	Two locations within Tampa Bay	Maximum: 177.5 dB @ 1600 Hz Broadband: 186.4 dB

DWP = Deepwater Port; HDD = horizontal direction drilling; STL = submerged turret loading.

For the purposes of noise modeling, a series of modeling scenarios were developed (JASCO, 2008, 2010). These scenarios considered all noise sources and were developed to thoroughly characterize the various construction/installation activities expected (**Table 1-3**). Given that underwater noise would travel in all directions from their source, **Table 1-3** also presents the radial distances that various noise are expected to reach, using the 180- and 120-dB regulatory noise exposure threshold levels for Level A and Level B harassment for continuous and intermittent sound sources, respectively. **Table 1-3** also identifies the radial distances for impulsive noise (i.e., pile driving) using the 180- and 160-dB threshold levels for Level A and Level B harassment, respectively. Modeling scenario locations are also shown in **Figure 1-4**.

Figure 1-4 Location of Noise Modeling Sites



(Dots denote key points along the shuttle regasification vessel [SRV] carrier route and pipeline. Red dots represent model sites.)

During the construction period, impact hammering would produce the loudest noise levels, but would likely occur for short periods of time. Noise impacts from pipelaying are similar and would encompass a 6.0 or 7.5 kilometer radius at 120 dB inshore and offshore, respectively. Pipelaying in Passage Key will generate the 120 dB contour at 1.6 kilometers. The radii of noise impacts vary depending on water depth because the transmission of lower-frequency sound waves can be significantly reduced in shallower water. As a result, the Level A and Level B radii in Passage Key are much shorter than the radii in Tampa Bay and offshore. Pipeline burial using the plow system produces the 120 dB radius at 6.7 kilometers inshore and 8.4 kilometers offshore. Impact hammering offshore and inshore would encompass a radius that is approximately 0.18 and 0.3 kilometer, respectively, at the Level A threshold; Level B thresholds, at 160 dB for this impulsive source, produce isopleths at 1.9 and 4.5 kilometers inshore and offshore, respectively.

Although sounds created by construction equipment and vessels would be continuous during pipeline installation, activities would progress slowly along the route as the pipeline is laid and buried and the trench backfilled. Thus, any one area would be subject to the maximum sound levels for only 1 to 2 days each time as the construction activities pass that area.

Table 1-3 Construction/Installation Scenarios Modeled During the Port Dolphin Noise Analysis and Radial Distance to Regulatory Thresholds (Adapted from: JASCO, 2008, 2010)

Activity	Sources Included	Location	Radial Distance	Type of Sound
Buoy Installation	Crane vessel, cargo barge, support vessel	North STL buoy (DWP site offshore)	180 dB: <0.2 km 120 dB: 3.9 km	Continuous, transient (support vessel only)
Impact Hammering, offshore	Impact hammer (pile driving)	Piggable "Y" site (between STL buoy sites)	180 dB: 0.18 km 160 dB: 4.5 km	Impulsive (pulsive)
Pipelaying, offshore	Barge, two anchor handling tugs, support tug	15-m isobath	180 dB: <0.2 km 120 dB: 7.5 km	Continuous, transient (anchor handling and support tugs only)
Pipelaying, inshore (Tampa Bay)	Barge, two anchor handling tugs, support tug	Within Tampa Bay	180 dB: <0.2 km 120 dB: 6.0 km	Continuous, transient (anchor handling and support tugs only)
Pipeline Burial – plowing, offshore	Plow system, two anchor handling tugs	15-m isobath	180 dB: <0.2 km 120 dB: 8.4 km	Continuous, transient
Pipeline Burial – plowing, inshore (Tampa Bay)	Plow system, two anchor handling tugs	Within Tampa Bay	180 dB: <0.2 km 120 dB: 6.7 km	Continuous, transient
HDD Drilling	Floating spud barge, crane mounted drill, welding equipment, air compressor, generator	Two HDD locations, inshore waters, Tampa Bay	180 dB: <0.01 km 120 dB: 0.24 km	Continuous
HDD Vibratory Driving	Floating spud barge, vibrator, welding equipment, air compressor, generator	Two HDD locations, inshore waters, Tampa Bay	180 dB: <0.01 km 120 dB: 12.6 km	Continuous

DWP = Deepwater Port; HDD = horizontal directional drilling; STL = submerged turret loading.

Notes:

- All distances are **unweighted, 95th percentile radial distances.** Please see **Appendix C** for additional modeling details.
- Behavioral disruption (Level B take) is considered to have occurred when marine mammals are exposed to sounds at or above 160 dB re 1µPa RMS for impulse sounds (e.g., impact pile driving) and 120 dB re 1µPa RMS for non-pulse noise (e.g., vibratory pile driving), but below the 180 dB re 1µPa RMS threshold for marine mammal (non-pinniped) injury level.
- Conservative estimators are used for all 180 dB calculations except offshore impact hammering. While the noise modeling results indicate that the radial distance from source to the 180 dB isopleth is <0.2 km, the <0.2 km distance is typically applicable to more than one threshold. For example, for buoy installation, the radial distance of <0.2 km is applicable to 190, 180, 170, 160, and 150 dB thresholds (see **Appendix C** for additional details). A second conservative estimator is used when area (and subsequent take calculations) are based on a 0.2 km radius.

1.3 PORT OPERATIONS

1.3.1 Description of Port Operations

The DWP operations include SRV maneuvering/docking, regasification of LNG cargo, and debarkation. The SRVs are expected to approach the DWP from the south. In the open ocean, the SRVs typically travel at speeds of up to 19.5 knots, reducing to less than 14 knots at full maneuvering speed. However, once approaching the vicinity of the DWP, the SRVs would slow to about half speed, within approximately 16 to 25 kilometers of the DWP. Inside the safety zone, the SRVs' main engines will be placed in dead slow ahead or dead slow mode, with final positioning and docking to occur using thrusters. Expected SRV transit, approach, and maneuvering/docking characteristics are outlined in **Table 1-4**. Only the maneuvering/docking activities and their associated noise sources (i.e., thrusters) are considered in this application; transit and approach maneuvers are considered part of routine vessel transit.

Table 1-4 Shuttle Regasification Vessel (SRV) Speeds and Thruster Use During Transit, Approach, and Maneuvering/Docking Operations at the Port Dolphin Deepwater Port (DWP) (Adapted from: JASCO, 2008)

Zone	Speed limit	Thrusters in Use
>33 km (18 nmi) from DWP	Full service speed (36 km/h, 19.5 kn)	No
25 to 33 km (14 to 18 nmi) from DWP	Full maneuver speed (<26 km/h, <14 kn)	No
16 to 25 km (9 to 14 nmi) from DWP	Half ahead (<19 km/h, <10 kn)	No
5 to 16 km (3 to 9 nmi) from DWP	Slow ahead (<11 km/h, <6 kn)	No
5 km (3 nmi) from DWP (edge of safety zone)	Dead slow ahead (<8.3 km/h, <4.5 kn)	Bow and stern thrusters in operation
Inside safety zone (<5 km [<3 nmi] from DWP)	Dead slow ahead (<5.6 km/h, <3 kn)	Bow and stern thrusters in operation
Docking	Dead slow	2 bow thrusters; possibly 1 to 2 stern thrusters in operation

Based on a regasification cycle of approximately 8 days and projected DWP throughput during the first several years (400 million bcf), vessel traffic during operations is projected to consist of 46 SRV trips per year. Loading operations (which are not expected to occur in U.S. territorial waters) would typically require approximately 1 day for berthing the SRV, loading the LNG, and preparing for departure from the LNG pier at the supply location.

1.3.2 Sounds from Port Operations

Sources of underwater noise from the operations of the DWP are expected to include vessel maneuvering and docking, and regasification. While the main noise source during SRV transit and approach to the DWP will originate from the SRV main engines (i.e., predominantly in low frequencies), the primary noise source during maneuvering and docking will be the SRV thrusters. The total frequency range considered for the SRV thrusters ranged from 10 to 2,000 Hz.

An additional underwater noise source is the sound produced by the flow of gas through the proposed flowline, although very little noise in the underwater environment would be expected (JASCO, 2008); therefore, this source was not modeled.

Noise modeling indicates that, overall, operational noise associated with the proposed project is consistent with other man-made underwater noise sources in the area (e.g., commercial shipping and dredging). Maximum and broadband noise source levels are provided in **Table 1-5** for Port Dolphin operations, divided into maneuvering/docking and regasification operations. Complete third-octave band source levels for operational modeling scenarios are presented in **Appendix A**. Noise modeling results for maneuvering/docking and regasification operations are outlined in **Table 1-6**. Given that underwater noise would travel in all directions from their source, **Table 1-6** also presents the radial distances that various noise are expected to reach, using the 120- and 180-dB regulatory noise exposure threshold levels.

Table 1-5 Source Levels from Shuttle Regasification Vessel (SRV) Maneuvering/Docking and Regasification Operations at the Port Dolphin Deepwater Port (DWP) (Adapted from: JASCO, 2008)

Source	Activity	Source Levels (dB re 1µPa)
Maneuvering/Docking		
SRV	Maneuvering and docking, with thrusters	Maximum: 171.5 dB @ 10-100 Hz Broadband: 182.6 dB
Operations		
SRV	Regasification	Maximum: 151.2 dB @ 2,000 Hz Broadband: 164.6 dB

Table 1-6 Operational Scenarios Modeled During the Port Dolphin Noise Analysis and Radial Distance to Regulatory Thresholds (Adapted from: JASCO, 2008, 2010)

Activity	Source	Location	Radial Distance	Sound Type
Maneuvering/Docking				
Docking mooring buoy, dead slow, plus two bow thrusters and one stern thruster	SRV	At the STL buoy	180 dB: <0.01 km 120 dB: 3.6 km	Intermittent, transient
Regasification				
Regasification	SRV	Docked, at the Port	180 dB: 0.0 km 120 dB: 0.17 km	Continuous

2.0 Dates, Duration, and Geographic Location of the Port Dolphin LNG Terminal and Associated Pipeline Operations

This section addresses the NMFS IHA/LOA requirement to identify the dates and duration of such activity and the specific geographic region where it will occur.

2.1 CONSTRUCTION DATES AND DURATION

Construction of Port Dolphin would proceed in two phases, lasting a total of approximately 22 months, with the DWP expected to commence operations in the third quarter of 2013. The marine construction activities are expected to last approximately 11 months. Construction and installation is anticipated to occur in the following sequence:

- Installation of the Port Manatee HDD, with installation proceeding from onshore to offshore;
- Installation of anchor piles and mooring lines at the DWP location;
- Construction and installation of the HDD pipe sections for the drills under the Gulfstream pipeline;
- Installation of pipe segments between Port Manatee HDD and the Gulfstream HDDs;
- Installation of the Skyway Bridge section of the pipe, requiring dredging through the causeway;
- Installation of STL buoys;
- Installation of two risers from the PLEMs;
- Installation of north and south PLEMs with pig receivers;
- Performance of pipelay and diving operations toward the piggable-Y;
- Installation of the flowlines on the seafloor;
- Burial of the pipeline or installation of concrete mattresses, as necessary, after all tie-ins are complete;
- Conduction of pipeline testing (i.e., pigging and hydrostatic testing) upon completion of burial operations; and
- Demobilization of offshore construction equipment.

A projected schedule for construction and installation activities is outlined in **Table 2-1**.

2.2 SPECIFIC GEOGRAPHIC REGION

The Port Dolphin Port would be located in the eastern Gulf of Mexico approximately 45 kilometers (28 miles) off the western coast of Florida, and approximately 68 kilometers (42 miles) from Port Manatee (which is located in Tampa Bay). The precise locations of the north and south DWP buoys are provided in **Table 2-2**. The water depth at the port is approximately 30.5 m (100 ft). The location of the offshore DWP and gas transmission pipeline to shore are shown in **Figure 2-1**. The latitude-longitude coordinates for the noise modeling scenarios are summarized in **Table 2-2**.

Table 2-1 Projected Schedule for Construction and Installation Activities, Port Dolphin Deepwater Port

Construction and Installation Activity	Month 1				Month 2				Month 3				Month 4				Month 5				Month 6				Month 7				Month 8				Month 9				Month 10				Month 11			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Shore Approach HDD	■	■	■																																									
Gulfstream P/L HDD Crossing - West		■	■	■																																								
Gulfstream P/L HDD Crossing - East					■	■	■																																					
Specialty Construction Areas:																																												
Skyway Bridge Crossing				■	■	■																																						
Flotation Ditch	■																																											
Lay Pipeline:																																												
Transmission Pipeline										■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■																	
North Flowline																											■																	
South Flowline																												■																
Final Tie-ins																																		■	■									
Filling, Testing, and Dewatering																																				■	■	■	■	■				
Pipeline Burial/Covering:																																												
Plowing											■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■											
Install Mattresses																	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■								
STL Buoy Installation							■	■	■	■	■	■																																
Impact Hammering	■	■	■	■	■	■																																						
Projected Season	Summer											Fall												Winter												Spring								

Notes:

a) Construction is continuous from mobilization to demobilization (i.e., no work stoppages due to weather or environmental issues).
b) Port Dolphin will utilize the same barge to lay and bury (plow) the pipeline.
c) Passage Key is currently assumed to be a conventional lay and bury; HDD remains an option.
d) The schedule is presented as a conservative approach (i.e., most disturbance and turbidity) with field work expected to commence July 2012.

Figure 2-1 Location of Port Dolphin Deepwater Port and Associated Pipeline to Shore

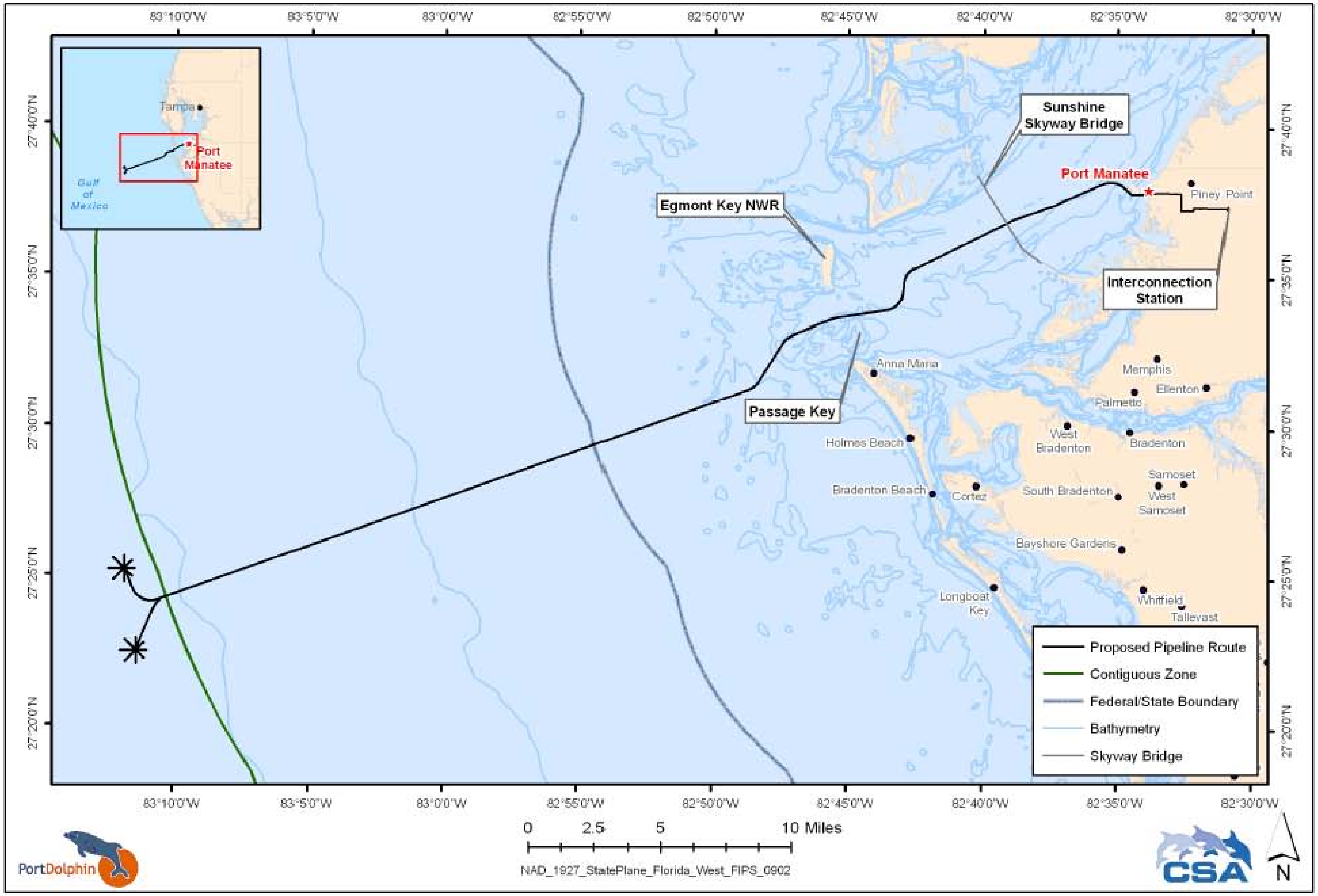


Table 2-2 Latitude-Longitude Coordinates for Port Dolphin Deepwater Port (DWP), Pipeline Waypoints, and Locations of Port Dolphin Noise Modeling Scenarios

Facility or Scenario	Location	Latitude (N)	Longitude (W)
DWP Location and Pipeline Waypoints			
DWP	North buoy	27° 25'12.14"	83° 11' 50.11"
DWP	South buoy	27° 22'28.73"	83° 11' 22.49"
Pipeline Waypoint - Offshore	Curve	27° 31’ 17.51”	82° 48’ 41.55”
Pipeline Waypoint - Offshore	Curve	27° 32’ 51.77”	82° 47’ 23.55”
Pipeline Waypoint - Inshore	Curve	27° 33’ 55.85”	82° 43’ 34.09”
Pipeline Waypoint - Inshore	West Gulfstream HDD	27° 34’ 42.35”	82° 42’ 55.60”
Pipeline Waypoint - Inshore	East Gulfstream HDD	27° 37’ 23.47”	82° 37’ 29.94”
Pipeline Waypoint - Inshore	Shore Approach HDD	27° 27’ 48.67”	82° 34’ 28.82”
Modeling Construction Scenarios			
Installation of anchors, buoys, and anchor chains	North buoy	27° 25'12.14"	83° 11' 50.11"
Impact pile driving (offshore)	Piggable “Y” site	27° 24' 13.06"	83° 10' 27.72"
Pipe laying (offshore)	15-m isobath	27° 28' 43.32"	82° 56' 41.64"
Pipe laying (inshore)	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
Pipeline burial—plowing (offshore)	15-m isobath	27° 28' 43.32"	82° 56' 41.64"
Pipeline burial—plowing (inshore)	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
HDD Drilling	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
HDD Vibratory Driving	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
Modeling Operational Scenarios			
Docking	North buoy	27° 25'12.14"	83° 11' 50.11"
Regasification	North buoy	27° 25'12.14"	83° 11' 50.11"

HDD = horizontal directional drilling.

3.0 Marine Mammal Species and Abundance in the Port Dolphin Area

This section addresses the NMFS IHA/LOA requirement to characterize the species and numbers of marine mammals in the area.

3.1 SPECIES PRESENCE

Two marine mammal species are most likely to occur in the project area. Bottlenose dolphins and Atlantic spotted dolphins are likely to be present in continental shelf and coastal waters, including the STL buoy locations and along the pipeline route. In a letter to the USCG dated May 29, 2008 providing comments on the Port Dolphin DEIS (U.S. Maritime Administration and U.S. Coast Guard, 2008), NMFS identified the need to obtain an IHA to address the potential harassment of marine mammal species that may be present in the Port project area – specifically, bottlenose dolphin and Atlantic spotted dolphin.

A third marine mammal species, the Florida manatee, occurs primarily in coastal waters within Tampa Bay and would not be expected to occur at the STL buoy locations or along open water, offshore portions of the pipeline route. The Florida manatee is an endangered species, whereas the bottlenose dolphin and Atlantic spotted dolphin are not endangered or threatened. Because manatees are under the jurisdiction of the U.S. Fish and Wildlife Service, this species will not be discussed further in this IHA/LOA request to NMFS. From a broader perspective, 29 species of marine mammals are known to occur in the Gulf of Mexico (**Table 3-1**), including 7 baleen whales (Suborder Mysticeti), 21 toothed whales (Suborder Odontoceti), and the Florida manatee (Order Sirenia) (Jefferson et al., 1993; Würsig et al., 2000).

The cetacean fauna of the northern and eastern Gulf of Mexico continental shelf, including the project area, typically consists of the bottlenose dolphin and the Atlantic spotted dolphin (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 1998; Davis et al., 2000; Würsig et al., 2000). At the shelf edge and within the deeper waters of the continental slope, the cetacean community typically includes 19 species, including the Bryde's whale, sperm whale, pygmy and dwarf sperm whales, three species of beaked whales, and 12 members of the oceanic dolphin family (Davis and Fargion, 1996; Jefferson and Schiro, 1997; Davis et al., 1998; Davis et al., 2000; Würsig et al., 2000). Oceanographic features (e.g., eddies) are important factors in determining the distribution of cetaceans, given that the prey of marine mammals are attracted to areas of increased primary productivity associated with these features (Biggs et al., 2000; Wormuth et al., 2000; Davis et al., 2002).

The following discussions of the population status of Gulf of Mexico marine mammals use categories adapted from Würsig et al. (2000):

- Common: A species that is abundant and widespread throughout the region in which it occurs;
- Uncommon: A species that does not occur in large numbers and may or may not be widely distributed throughout the region in which it occurs;
- Rare: A species present in such small numbers throughout the region that it is seldom seen; and
- Extralimital: A species known on the basis of few records that are probably the result of unusual movements of few individuals into the region.

Table 3-1 Marine Mammals of the Gulf of Mexico Region

Species	Status[a]	Occurrence[b]	Typical Habitat		
			Coastal	Shelf	Slope/Deep
ORDER CETACEA					
Suborder Mysticeti (Baleen whales)					
Family Balaenidae					
Eubalaena glacialis (Northern right whale)	E	1	--	X	X
Family Balaenopteridea					
Balaenoptera musculus (Blue whale)	E	1	--	X	X
Balaenoptera edeni (Bryde's whale)	--	3	--	X	X
Balaenoptera physalus (Fin whale)	E	2	--	X	X
Megaptera novaeangliae (Humpback whale)	E	2	--	X	X
Balaenoptera acutorostrata (Minke whale)	--	2	--	X	X
Balaenoptera borealis (Sei whale)	E	2	--	X	X
Suborder Odontoceti (Toothed whales and dolphins)					
Family Physeteridae					
Kogia simus (Dwarf sperm whale)	--	3	--	X	X
Kogia breviceps (Pygmy sperm whale)	--	3	--	X	X
Physeter macrocephalus (Sperm whale)	E	4	--	X	X
Family Ziphiidae					
Mesoplodon densirostris (Blainville's beaked whale)	--	2[c]	--	X	X
Ziphius cavirostris (Cuvier's beaked whale)	--	2[c]	--	X	X
Mesoplodon europaeus (Gervais' beaked whale)	--	3[c]	--	X	X
Mesoplodon bidens (Sowerby's beaked whale)	--	1[c]	--	X	X
Family Delphinidae					
Stenella frontalis (Atlantic spotted dolphin)	--	4	X	X	X
Tursiops truncatus (Bottlenose dolphin)	--	4	X	X	X
Stenella clymene (Clymene dolphin)	--	4	--	X	X
Pseudorca crassidens (False killer whale)	--	3	--	X	X
Lagenodelphis hosei (Fraser's dolphin)	--	4	--	X	X
Orcinus orca (Killer whale)	--	3	--	--	X
Peponocephala electra (Melon-headed whale)	--	4	--	--	X
Stenella attenuata (Pantropical spotted dolphin)	--	4	--	X	X
Feresa attenuata (Pygmy killer whale)	--	3	--	X	X
Globicephala macrorhynchus (Short-finned pilot whale)	--	4	--	X	X
Grampus griseus (Risso's dolphin)	--	4	--	X	X
Steno bredanensis (Rough-toothed dolphin)	--	4	--	X	X
Stenella longirostris (Spinner dolphin)	--	4	--	X	X
Stenella coeruleoalba (Striped dolphin)	--	4	--	X	X
ORDER SIRENIA (Dugongs and manatees)					
Family Trichechidae					
Trichechus manatus latirostris (Florida manatee)	E	2	X	--	--

[a] Status: E = endangered under the Endangered Species Act of 1973.
[b] Occurrence: 1 = extralimital; 2 = rare; 3 = uncommon; 4 = common (adapted from Würsig et al., 2000).
[c] Beaked whales in the Gulf of Mexico may be uncommon or common rather than rare or extralimital. Their population status is uncertain because they are difficult to see and identify to species. Most surveys have been conducted in sea states that are not optimal for sighting beaked whales.

The U.S. Department of the Navy (USDON, 2003) reviewed available marine mammal survey data for the eastern Gulf of Mexico and summarized species presence and distribution on a seasonal basis. Relevant findings pertinent to marine mammals include the following:

- Spring (April through June) is the season with the highest number of cetacean occurrence records; high cetacean occurrence records were also noted for summer (July through September);
- Fall (October through December) and winter (January through March) are the two seasons with the lowest number of occurrence records and total number of cetaceans;
- Higher numbers in spring and summer are possibly due to the higher survey effort usually expended during those months (when sighting conditions are optimal); and
- There are fewer sighting records in fall than in the other seasons, likely attributable to suboptimal survey conditions (i.e., reduction in sightability).

The distribution of marine mammals is affected by several factors, one of which is prey distribution. The presence of prey is frequently influenced by bathymetric and oceanographic features, including bathymetry, water temperature, and salinity (Katona and Whitehead, 1988). The presence of specific hydrographic and/or bathymetric features and discontinuities (e.g., abrupt temperature differentials, current edges, upwelling areas, sea mounts, banks, shoals, or the continental shelf edge) may also affect marine mammal distribution (USDON, 2003).

Data historically acquired during aerial and shipboard surveys conducted within the eastern Gulf of Mexico were analyzed by marine mammal researchers and summarized in USDON (2003). To increase the utility of the species sightings data, marine mammal occurrence and distribution data were partitioned into both seasonal and water depth categories. This partitioning is supported by distribution patterns (e.g., sightings over the continental shelf, sightings beyond the continental shelf) observed during large-scale surveys (e.g., Cetacean and Turtle Assessment Program [CETAP] surveys; CETAP, 1982; Hain et al., 1985; Winn et al., 1987). Seasonal categories included in USDON (2003) and employed in this analysis were:

- Winter: December 21 through March 20;
- Spring: March 21 through June 20;
- Summer: June 21 through September 20; and
- Fall: September 21 through December 20.

Water depth categories, or depth strata, included in USDON (2003) and employed in this analysis were as follows:

- Nearshore: 0 to 20 fath or 0 to 120 feet (0 to 36.6 meters);
- Mid-shelf: 20 to 50 fath or 120 to 300 feet (36.6 to 91.4 meters);
- Shelf-edge: 50 to 1,100 fath or 300 to 6,600 feet (91.4 to 2,000 meters); and
- Slope: >1,100 fath or >6,600 feet (>2,000 meters).

Mysticete Whales

The Bryde's whale is the most frequently sighted mysticete in the Gulf, though considered uncommon. Strandings and sightings data suggest that this species may be present throughout the year, generally in the northeastern Gulf near the 328-foot (100-meter) isobath between the Mississippi River delta and southern Florida (Davis et al., 2000; Würsig et al., 2000). The remaining six mysticete whales (blue, fin, humpback, minke, North Atlantic right, and sei whales) are considered rare or extralimital in the Gulf of Mexico (Jefferson, 1996; Jefferson and Schiro, 1997). Because of their geographic range and/or preferred water depths, it is possible but not likely that mysticete whales, including the Bryde's whale, could occur within the project area.

Odontocete Whales and Dolphins

Based on systematic surveys conducted during the mid to late 1990s (i.e., GulfCet II), the most commonly sighted cetaceans on the Gulf of Mexico continental shelf (in terms of numbers of individual sightings) were bottlenose dolphins and Atlantic spotted dolphins. The most abundant cetacean within the Gulf of Mexico, in terms of population densities, is the bottlenose dolphin (Mullin and Hoggard, 2000; Waring et al., 2006). Water depths where sightings of bottlenose dolphin occurred ranged from 30 to 702 meters.

Bottlenose dolphins along the U.S. coastline are believed to be organized into local populations, or stocks, each occupying a small region of coast with some migration to and from inshore and offshore waters (Schmidly, 1981). NMFS recognizes several stocks of bottlenose dolphins in the northern Gulf of Mexico, including an outer continental shelf stock; a continental shelf edge and continental slope stock; western, northern, and eastern Gulf of Mexico coastal stocks; and a Gulf of Mexico bay, sound, and estuarine stock (Blaylock et al., 1995; Waring et al., 2006). It is expected that bottlenose dolphins could occur within both offshore and nearshore waters of the project area. If present, the bottlenose dolphins would likely be represented by individuals from the eastern Gulf coastal stock and the Gulf of Mexico bay, sound, and estuarine stock.

Atlantic spotted dolphins are widely distributed in warm temperate and tropical waters of the Atlantic Ocean, including the Gulf of Mexico (Waring et al., 2006). In the northern Gulf, these animals occur mainly on the continental shelf (Jefferson and Schiro, 1997). During GulfCet II aerial and shipboard surveys in the northern Gulf of Mexico, Atlantic spotted dolphins were seen at water depths ranging from 22 to 222 meters (Mullin and Hoggard, 2000). On the shelf, they were second in abundance after bottlenose dolphins. Atlantic spotted dolphins can be expected to occur on the continental shelf during all seasons. However, they may be more common during spring (Jefferson and Schiro, 1997; Mullin and Hoggard, 2000). It is expected that Atlantic spotted dolphins could occur within offshore waters of the project area.

Most of the other odontocete whales and dolphins known to occur within the Gulf (**Table 3-1**) are considered common. Exceptions include the beaked whales, with most being rare or extralimital, and the dwarf and pygmy sperm whales, which are considered uncommon. The frequency of occurrence of beaked whales and dwarf and pygmy sperm whales are most likely underestimated because these "cryptic" species are submerged much of the time and avoid aircraft and ships (Würsig et al., 1998). Consequently, beaked whales may be uncommon or common rather than rare or extralimital. The sperm whale is considered common in the Gulf (Jefferson, 1996; Jefferson and Schiro, 1997; Davis et al., 2000; Waring et al., 2006). Sightings data suggest a Gulf-wide distribution on the continental slope. Congregations of sperm whales are common along the continental shelf edge in the vicinity of the Mississippi River delta in water depths of 500 to 2,000 meters. From these consistent sightings, it is believed that there is a resident population of sperm whales in the Gulf consisting of adult females, calves, and immature individuals (Brandon and Fargion, 1993; Mullin et al., 1994; Sparks et al., 1993; Jefferson and Schiro, 1997). Though most odontocete whales are considered common in the Gulf of

Mexico, they prefer waters of the continental shelf edge (approximately 656 feet [200 meters]) and continental slope. Therefore, it is unlikely that these species would occur within the project area.

3.2 ABUNDANCE AND DENSITY CALCULATIONS

This analysis has utilized the NMFS marine mammal stock assessments and the USDON (2003) density calculations as primary sources of information for population and density estimates, respectively. NMFS conducts regular (i.e., typically bi-annual) reviews of marine mammal stocks in U.S. waters, providing the most current data on stock size and status. The USDON (2003) conducted a thorough analysis of available marine mammal survey data and prepared species-specific seasonal and depth-based estimates of marine mammal densities in U.S. waters.

The marine mammal species most likely to be present in the Port Dolphin project area include bottlenose and Atlantic spotted dolphins. These species occur within the nearshore depth stratum (0 to 36.6 meter water depths) of the eastern Gulf of Mexico, as characterized in a previous review and summarization of historic survey data and sightings from platforms of opportunity conducted by the USDON (2003).

3.2.1 Bottlenose Dolphin

The current population size for the eastern Gulf stock of bottlenose dolphins is classified as “currently unknown” by NMFS for purposes of calculating potential biological removal (PBR), as the survey data for this species is more than 8 years old. The latest population estimates for bottlenose dolphins in the eastern Gulf of Mexico (eastern Gulf stock) are 9,912 (N_{best}) and 8,963 (N_{min}) based on 1991 to 1994 survey data (NMFS, 2005). The latest estimates of the Gulf of Mexico bay, sound, and estuarine stock in Tampa Bay is 559 individuals (NMFS, 2009a).

3.2.2 Atlantic Spotted Dolphin

The current population size for the Atlantic spotted dolphin in the northern Gulf of Mexico is also classified as “currently unknown” for the purposes of calculating PBR because survey data are more than 8 years old. The latest population estimate for Atlantic spotted dolphin in the eastern Gulf is 37,611 (N_{best})(NMFS, 2009b).

3.2.3 Marine Mammals in the Adjacent Depth Stratum

Because several sound sources may extend into waters beyond the nearshore depth stratum, the marine mammal species present in deeper water (i.e., within the adjacent mid-shelf depth stratum) and their respective seasonal densities have also been summarized. Density estimates for nearshore and mid-shelf strata are outlined in **Table 3-2**, although marine mammals most likely to be affected by Port Dolphin sound sources occur within the nearshore depth stratum (0 to 36.6 meters).

Table 3-2 Density Estimates of Marine Mammals (individuals per 39 square miles [100 square kilometers]) in the Nearshore (0 to 36.6 meters) and Mid-Shelf (36.6 to 91.4 meters) Depth Stratum of the Eastern Gulf of Mexico (Adapted from: USDON, 2003)

Species/Species Group	Density (Individuals/39 mi² [100 km²])			
	Winter	Spring	Summer	Fall
Nearshore Depth Stratum (0 to 36.6 meters)				
MYSTICETES				
None	--	--	--	--
ODONTOCETES				
Atlantic spotted dolphin	2.243	10.752	2.524	10.752
Bottlenose dolphin	10.913	21.986	8.241	26.744
Total	**13.156**	**32.738**	**10.765**	**37.496**
Mid-Shelf Depth Stratum (36.6 to 91.4 meters)				
MYSTICETES				
None	--	--	--	--
ODONTOCETES				
Atlantic spotted dolphin	11.630	21.699	17.354	22.916
Bottlenose dolphin	7.410	2.588	11.707	10.856
Dwarf/pygmy sperm whale	0.000	0.011	0.011	0.000
Rough-toothed dolphin	0.000	0.000	0.000	0.400
Total	**19.040**	**24.298**	**29.072**	**34.172**

4.0 Affected Species Status and Distribution

Two marine mammal species are most likely to occur in the immediate project area. Bottlenose dolphins and Atlantic spotted dolphins are likely to be present in continental shelf and coastal waters, including the STL buoy locations and along the pipeline route. Bottlenose dolphin and Atlantic spotted dolphin are not endangered or threatened. However, five U.S. stocks of bottlenose dolphins are classified as "strategic" by NMFS: Eastern Gulf of Mexico Coastal; Western Gulf of Mexico Coastal; Northern Gulf of Mexico Coastal; Gulf of Mexico Bay, Sound and Estuarine; and Western North Atlantic Coastal. The Western North Atlantic Coastal stock is listed as “depleted” under MMPA, but this does not occur in the project area. In the project area, the Northern Gulf of Mexico Coastal and Gulf of Mexico Bay, Sound, and Estuarine bottlenose dolphin stocks are strategic.

In a letter to the USCG dated May 29, 2008 providing comments on the Port Dolphin DEIS (U.S. Maritime Administration and U.S. Coast Guard, 2008), NMFS identified the need to obtain an IHA for bottlenose dolphin and Atlantic spotted dolphin. The bottlenose dolphin and Atlantic spotted dolphin are considered the marine species to have the greatest potential for impacts arising from the Port project.

Because several of the project-related sound sources may extend several kilometers from their source (e.g., to attenuate to the 120 dB noise exposure threshold for Level B harassment), this analysis has also considered marine mammals that may be present in the adjacent depth stratum – the mid-shelf region for sound sources emanating from the DWP construction (i.e., pipelaying offshore) and operation (i.e., maneuvering and docking using thrusters). Bottlenose dolphins and Atlantic spotted dolphins are likely to be present in continental shelf waters (i.e., mid-shelf depth stratum) year-round; in addition, dwarf/pygmy sperm whales and rough-toothed dolphins may also be expected to occur in the mid-shelf stratum on a seasonal basis. None of the marine mammal species likely to be present in these two depth strata are listed as endangered. All marine mammals are afforded protection under MMPA. Port Dolphin has also prepared a Marine Protected Species Management Plan for Offshore Construction of the Port Dolphin Energy LLC Deepwater Port, included as **Appendix B** of this application.

5.0 Type of Incidental Take Requested

This section addresses the NFMS requirement to characterize the type of incidental take authorization that is being requested (i.e., takes by harassment only or takes by harassment and/or injury) and the method of take. Only take by harassment (i.e., Level B incidental take, potential behavioral modification), resulting from exposure to noise, is predicted to occur as a result of Port installation and construction activities or Port operations. No Level A take (i.e., injury) is expected to result from either Port installation and construction activities or Port operations. The sound pressure level (SPL) thresholds employed in this analysis conform to those applied by NMFS in recent IHA and/or LOA authorizations, including Northeast Gateway LNG (NMFS, 2007, 2008a, 2009c) and Neptune LNG Deepwater Port (NMFS, 2008b, 2009d, 2010). These SPLs, as applicable to cetaceans, are as follows:

- Level A harassment: 180 dB re 1µPa root mean square (RMS) and greater;
- Level B harassment; impulse noises: 160 dB re 1µPa RMS and greater; and
- Level B harassment; intermittent and continuous noises: 120 dB re 1µPa RMS and greater.

While several of the Port Dolphin noise sources exceed the 180 dB Level A threshold, no Level A harassment is expected. Based on the sound sources analyzed for construction and operations of Port Dolphin, the predicted distances from each source (which exceeds the 180 dB SPL) to the 180 dB level range from 10 to 300 meters. Because the relative densities of bottlenose and Atlantic spotted dolphins in the project area are low and the areas ensonified to a level >180 dB are so small, the possibility of Level A take is practically zero.

In a letter to the USCG dated May 29, 2008 providing comments on the Port Dolphin DEIS, NMFS identified the need of an IHA for bottlenose dolphin and Atlantic spotted dolphin. A 1-year IHA is, therefore, sought for the initial phases of Port Dolphin's period of construction in 2012. Because construction will not be completed before the expiration of the initial IHA, Port Dolphin Energy LLC also requests that this application serve as the basis for issuance of a follow-on LOA to authorize non-lethal incidental takes by harassment during completion of construction activities in 2013 and for subsequent Port operations to be conducted following completion of port construction and installation activities.

6.0 Numbers of Marine Mammals that Might be Taken

This section addresses the NFMS requirement to quantify the numbers of marine mammals that might be taken by the proposed activity. Port Dolphin Energy LLC seeks authorization for potential "taking" of a small number of marine mammals in the eastern Gulf of Mexico under NMFS jurisdiction. Species for which authorization is sought during construction of the Port and associated pipeline include 2 of the 29 species known to occur in the Gulf of Mexico that have the highest likelihood of occurring in the Port Dolphin project area during construction and installation activities and Port operations. These 2 species were identified previously to have the highest likelihood of occurring in the project area during all seasons.

The only anticipated impact to marine mammals during construction and operation would be the short term displacement of marine mammals from areas ensonified by sound generated by equipment operation and vessel movement (e.g., thruster use). The construction and operational activities proposed by Port Dolphin are not expected to "take" more than a small number of marine mammals or have more than a negligible effect on their populations based on their seasonal density and distribution and their known reactions to exposure to such underwater sound sources. The seasonal nature of the construction and installation activities at Port Dolphin are highlighted in **Table 6-1**.

Table 6-1 Projected Construction and Installation Activities, by Season, and Port Operations. Schedule based on a projected field construction/installation start date of July 2012

Activity	Season
Construction and Installation	
Buoy Installation	Summer 2012
Offshore Impact Hammering	Summer 2012
Pipelaying Offshore	Late Summer-Fall 2012-Early Winter 2013
Pipelaying Inshore	Late Summer-Fall 2012-Early Winter 2013
Offshore Pipeline Burial	Fall 2012-Winter 2012-2013
Inshore Pipeline Burial	Fall 2012-Winter 2012-2013
HDD Drilling	Summer 2012
HDD Vibratory Driving	Summer 2012
Operations	
SRV Maneuvering/Docking	Year Round; 46 visits per year, total
Regasification	Year Round

HDD = horizontal directional drilling; SRV – shuttle regasification vessel.

The information contained in this section of the application relies on the noise modeling analysis completed by JASCO Research Limited in 2008 and 2010, which addressed the sound characteristics of construction and operations of the Port, local oceanographic and seafloor characteristics, and predicted sound attenuation to various regulatory sound exposure thresholds. The complete modeling reports are provided in **Appendices C** and **D**.

NMFS recognizes three kinds of sound: continuous, intermittent (or transient), and pulsive. Most of the Port Dolphin sound sources of potential concern are continuous. Many of the sounds will be transient in nature (i.e., the source of the noise moves), such as during vessel docking. Continuous sounds include underwater sound generated during pipeline construction, and operational underwater sound generated by maneuvering/docking and regasification. Regasification sounds are continuous (while the SRV is docked) and stationary. The positioning (maneuvering and docking) of SRVs using thrusters is intermittent (i.e., every 8 days) and of short duration (i.e., 10 to 30 minutes). The only pulsive sounds are associated with pile driving activities at the offshore Port location (i.e., associated with anchor installation activities).

Both continuous and intermittent sound sources are subject to NMFS acoustic exposure criteria, as applicable to cetaceans – 180 dB re 1 µPa (RMS) for Level A harassment and 120 dB re 1 µPa (RMS) for Level B harassment. Impulsive sounds are afforded different acoustic exposure thresholds by NMFS - 160 dB re 1 µPa (RMS).

6.1 CONSTRUCTION-RELATED SOUND FIELDS

Results of the modeled underwater analysis (JASCO, 2008, 2010) for Port Dolphin construction are summarized as follows:

- Buoy Installation: Installation of the buoys at the Port will produce continuous sound for a relatively short period of time during summer, with 120-dB isopleths located 3.9 kilometers from each STL buoy location and corresponding ensonification of approximately 48 square kilometers.
- Pipelaying: Pipelaying activities will generate continuous, transient, and variable sound levels during construction predominantly during fall, with some activity during late summer and early winter. Modeling conducted by JASCO (2008) indicates that, depending on location (offshore, inshore), the 120-dB isopleth for pipelaying activities will extend either 6.0 or 7.5 kilometers from the source, encompassing an area of 113 or 177 square kilometers, respectively.
- Pipeline Burial: Pipeline burial using the plow system will generate continuous, transient, and variable sound levels during construction, primarily during fall and winter; in addition, pipeline burial will be used infrequently during the construction period. Distances to the 120-dB isopleths will be 6.7 or 8.4 kilometers from the source, ensonifying an area of 141 or 222 square kilometers.
- Impact Hammering (Pile Driving, Offshore): Installation of anchors via pile driving is one of the loudest construction noise sources, slated to occur during summer. This impulsive sound will produce a 160-dB isopleths at 4.5 kilometers from each STL buoy location, ensonifying an area of approximately 64 square kilometers.
- HDD Drilling: Horizontal directional drilling within Tampa Bay will produce continuous sound levels and is expected to occur during summer. Modeling results (JASCO, 2010) indicate that the 120-dB isopleth will extend 0.24 kilometers from the drilling operation, ensonifying an area of approximately 0.2 square kilometers.
- HDD Vibratory Driving: Installation of the goal posts at each HDD location will produce a continuous sound for a relatively short period of time, exclusively during summer. The 120-dB isopleths for HDD vibratory driving will extend 12.6 kilometers from the source, ensonifying an area of 501 square kilometers.

Appendix E presents Level B harassment sound field graphics for construction activities.

6.2 OPERATION-RELATED SOUND FIELDS

Operation of the Port Dolphin DWP, including maneuvering/docking operations and regasification, is summarized as follows:

- SRV Maneuvering and Docking: Once the SRV completes its approach to Port Dolphin and is within approximately 5.6 kilometers of the Port, bow and stern thrusters will be utilized. Thruster use will vary, operating for 10 to 30 minutes to allow for the properly positioning of the vessel and allow for connection to the STL buoy. Docking or berthing will occur at alternate STL buoys approximately every 8 days. Noise modeling, assessing the periodic use of the thrusters (i.e., every 8 days) producing an intermittent and moving noise, indicated that the 120 dB isopleth will occur at 3.6 kilometers from the SRV, ensonifying an area of approximately 41 square kilometers.
- Regasification: The SRV will regasify its LNG cargo while attached to (i.e., berthed at) the STL buoy. Sound levels for regasification are low, with the 120 dB isopleths at 0.17 kilometer from the source. The total area ensonified to this level is approximately 0.09 square kilometers.

Appendix E presents Level B harassment sound field graphics for Port activities, including SRV maneuvering and docking, and regasification.

6.3 SOUND SOURCES AND THEIR OCCURRENCE IN VARIOUS DEPTH STRATA

Construction and operational noise from Port Dolphin was modeled on the basis of 11 scenarios, with calculation of radial distances to Level A and Level B acoustic harassment thresholds. Radii to the Level A threshold (i.e., 180 dB) ranged from 0.01 to 0.3 kilometers; Level A isopleths all occurred within the nearshore depth stratum.

Level B acoustic exposure thresholds vary depending on the nature of the sound source. The Level B threshold for continuous and intermittent sounds is 120 dB, while the Level B threshold for impulsive sounds is 160 dB. The majority of Port Dolphin sound sources are continuous or intermittent, with the exception of pile driving (i.e., impact hammering, offshore – possibly required to set buoy anchors). Given the relative magnitude of each sound source and the distances required to reach the Level B threshold, the radial distances were variable, ranging from 0.07 to 8.4 kilometers. Most Port Dolphin activities will occur within the nearshore depth stratum (within the 37-meter depth contour), as outlined in **Table 6-2**. The single exception, where ensonification of the mid-shelf stratum is predicted, includes only a very small percentage from offshore pipelaying activity. **Appendix E** provides graphics reflecting the predicted sound fields for each activity.

Table 6-2 Percentage of Level B Sound Occurrence by Depth Stratum

Activity	Nearshore Depth Stratum	Mid-shelf Depth Stratum
Construction		
Buoy Installation	100	0
Offshore Impact Hammering	100	0
Pipelaying Offshore	99.9	0.1
Pipelaying Inshore	100	0
Offshore Pipeline Burial	100	0
Inshore Pipeline Burial	100	0
HDD Drilling	100	0
HDD Vibratory Driving	100	0
Operations		
SRV Maneuvering/Docking	100	0
Regasification	100	0

HDD = horizontal directional drilling; SRV = shuttle regasification vessel.

6.4 TAKE ESTIMATES

Incidental take estimates are calculated based on:

1) the number of marine mammals that occur within each respective depth stratum, using species-specific and season-specific density estimates (i.e., number of individuals per 100 square kilometers);
2) the percentage of area ensonified within each depth stratum, by sound source; and
3) the areal extent of Level A and Level B sound fields, by sound source.

Determinations of area ensonified, by appropriate threshold, were calculated using radial distances as determined from noise modeling (see **Appendices C** and **D**). While modeling results for each sound source and for various sound thresholds presented both unweighted and M-weighted distances, incidental take estimates were derived only using flat-weighted (or unweighted) determinations. The total number of animals taken was determined by applying the modeled zone of influence (e.g., ZOI, the area ensonified using the 180-dB and 160-dB or 120-dB sound contours) and applying the species-specific seasonal densities within the respective depth stratum (USDON, 2003). The percentage of area within each depth stratum was then integrated into the seasonal, species-specific calculations.

6.4.1 Construction-Related Incidental Take

Sound from Port Dolphin construction activities is restricted predominantly to the nearshore depth stratum, with only a small portion of the offshore pipelaying activities having the potential to affect species within the adjacent mid-shelf stratum. Species potentially affected in the nearshore depth stratum include Atlantic spotted dolphin and bottlenose dolphin, while in the mid-shelf depth stratum Atlantic spotted and bottlenose dolphins are expected to occur with dwarf/pygmy sperm whales and rough toothed dolphins. **Table 6-3** summarizes projected incidental take, by species, for all construction-related Port Dolphin operations and all seasons. No Level A take is expected. The predicted distances from each construction source (which exceeds the 180 dB SPL) to the 180 dB level range from 10 to 300 meters. Because the relative densities of bottlenose and Atlantic spotted dolphins in the project area are low and the areas ensonified to a level >180 dB are so small, the possibility of Level A take from Port construction is practically zero. Only Level B take (i.e., potential behavioral modification) is predicted from Port construction activities.

Four of the eight construction and installation activities are scheduled to occur within a single season. Level B take (i.e., behavioral modification) estimates for these activities include the following:

- Buoy Installation: Scheduled to occur during summer; 6 individuals taken (2 Atlantic spotted; 4 bottlenose);
- Offshore Hammering: Scheduled to occur during summer; 7 individuals taken (2 Atlantic spotted; 5 bottlenose);
- HDD Drilling: Scheduled to occur during summer; 0 individuals taken; and
- HDD Vibratory Driving: Scheduled to occur during summer; 54 individuals taken (13 Atlantic spotted; 41 bottlenose).

Table 6-3 Summary of Level B Incidental Take (Potential Behavioral Modification) Estimates for Port Dolphin Construction and Installation Activities

Shaded areas indicate the scheduled season for each activity and the calculated take numbers

Season	Species	Buoy Install	Offshore Hammering	Pipeline Offshore[1]	Pipeline Inshore	Offshore Plowing	Inshore Plowing	HDD Drilling	HDD Vibratory Driving	Total	Season Total	Species Take[2]
Winter	Atlantic spotted	2	1	4	3	5	3	0	11	29	85	15
	Bottlenose dolphin	5	7	19	12	24	15	0	55	138		70
	Dwarf/pygmy sperm whale	-	--	0	--	--	--	--	--	--		0
	Rough toothed dolphin	-	--	0	--	--	--	--	--	--		0
Spring	Atlantic spotted	2	7	19	12	24	15	0	54	134	0	0
	Bottlenose dolphin	11	14	39	25	49	31	0	110	281		0
	Dwarf/pygmy sperm whale	--	--	0	--	--	--	--	--	--		0
	Rough toothed dolphin	--	--	0	--	--	--	--	--	--		0
Summer	Atlantic spotted	2	2	4	3	6	4	0	13	34	98	24
	Bottlenose dolphin	4	5	15	9	18	12	0	41	105		74
	Dwarf/pygmy sperm whale	--	--	0	--	--	--	--	--	--		0
	Rough toothed dolphin	--	--	0	--	--	--	--	--	--		0
Fall	Atlantic spotted	2	7	19	12	24	15	0	54	134	244	70
	Bottlenose dolphin	13	17	47	30	59	38	0	134	340		174
	Dwarf/pygmy sperm whale	--	--	0	--	--	--	--	--	--		0
	Rough toothed dolphin	--	--	0	--	--	--	--	--	--		0
Total Take by Activity, Winter		--	--	23	15	29	18	--	--	Winter Take[2]		85
Total Take by Activity, Spring		--	--	--	--	--	--	--	--	Spring Take		0
Total Take by Activity, Summer		6	7	19	12	--	--	0	54	Summer Take[2]		98
Total Take by Activity, Fall		--	--	66	42	83	53	--	--	Fall Take[2]		244

[1] - Construction and installation activities will affect only nearshore stratum species (i.e., Atlantic spotted and bottlenose dolphins), with the exception of offshore pipelaying activities, which have the potential to ensonify portions of the mid-shelf stratum. Therefore, dwarf/pygmy sperm whales and rough toothed dolphin are also considered to be potentially affected by this activity.

[2] - Total take calculations for the summer, fall, and winter seasons based on the assumption that offshore pipeline laying, inshore pipeline laying, offshore plowing, and inshore plowing will all occur during a respective season. Take estimates for each season, therefore, cannot be combined for a total take estimate for all construction and installation activities; see text for further explanation.

The window for four of the remaining construction and installation activities (i.e., offshore pipeline laying, inshore pipeline laying, offshore plowing, and inshore plowing) extends across portions of two or three seasons, although each activity is expected to be completed within a single season. Given this scheduling uncertainty, Level B take (i.e., behavioral modification) estimates have been calculated by activity as follows:

- Pipeline Offshore: Scheduled to occur during either late summer, fall, or early winter
  - 19 individuals taken in summer (4 Atlantic spotted; 15 bottlenose), or
  - 66 individuals taken in fall (19 Atlantic spotted; 47 bottlenose), or
  - 23 individuals taken in winter (4 Atlantic spotted; 19 bottlenose).
- Pipeline Inshore: Scheduled to occur during either late summer, fall, or early winter
  - 12 individuals taken in summer (3 Atlantic spotted; 9 bottlenose), or
  - 42 individuals taken in fall (12 Atlantic spotted; 30 bottlenose), or
  - 15 individuals taken in winter (3 Atlantic spotted; 12 bottlenose).
- Offshore Plowing: Scheduled to occur during either fall or winter
  - 83 individuals taken in fall (24 Atlantic spotted; 59 bottlenose), or
  - 29 individuals taken in winter (5 Atlantic spotted; 24 bottlenose).
- Inshore Plowing: Scheduled to occur during either fall or winter
  - 53 individuals taken in fall (15 Atlantic spotted; 38 bottlenose), or
  - 18 individuals taken in winter (3 Atlantic spotted; 15 bottlenose).

Given the scheduling uncertainty noted previously, Level B take estimates by season can be summarized as follows:

- During fall, inshore and offshore pipelaying and inshore and offshore plowing activities may cause behavioral disruption to as many as 70 Atlantic spotted dolphins and 174 bottlenose dolphins;
- During winter, inshore and offshore pipelaying and inshore and offshore plowing activities may cause behavioral disruption to as many as 15 Atlantic spotted dolphins and 70 bottlenose dolphins;
- During spring, no construction or installation activities are expected; no incidental take is predicted for this season; and
- During summer, buoy installation, offshore hammering, offshore and inshore pipeline installation, and HDD vibratory driving may result in Level B harassment to 24 Atlantic spotted dolphins and 74 bottlenose dolphins.

Table 6-4 summarizes Level B incidental take for each activity, based on expected season.

6.4.2 Operations-Related Incidental Take

Sounds from maneuvering/docking and regasification will be limited to the nearshore depth stratum. No operations noise above the regulatory threshold of concern will reach the mid-shelf depth stratum and its associated marine mammal fauna. Therefore, only Atlantic spotted and bottlenose dolphins have the potential to realize Level B incidental take (i.e., potential behavioral modification). No Level A take is expected from Port operations. Based on the sound sources analyzed for Port operations, only maneuvering/docking SPLs exceed the 180 dB threshold. Further, the range from this source to the 180 dB level is 10 meters. Because the relative densities of bottlenose and Atlantic spotted dolphins in the project area are low and the area ensonified to a level >180 dB is so small, the possibility of Level A take from Port operations is practically zero.

Table 6-4 Summary of Level B Incidental Take (Potential Behavioral Modification) Estimates by Activity and Species Associated with Port Dolphin Construction and Installation Activities

Species	Activity/Season													
	Buoy Installation	Offshore Hammering	Pipeline Installation Offshore[1]			Pipeline Installation Inshore			Offshore Plowing		Inshore Plowing		HDD Drilling	HDD Vibratory Driving
	Summer	Summer	Summer	Fall	Winter	Summer	Fall	Winter	Fall	Winter	Fall	Winter	Summer	Summer
Atlantic spotted dolphin	2	2	4	19	4	3	12	3	24	5	15	3	0	13
Bottlenose dolphin	4	5	15	47	19	9	30	12	59	24	38	15	0	41
Dwarf/pygmy sperm whale	--	--	0	0	0	--	--	--	--	--	--	--	--	--
Rough toothed dolphin	--	--	0	0	0	--	--	--	--	--	--	--	--	--
Total Take by Activity	**6**	**7**	**19**	**66**	**23**	**12**	**42**	**15**	**83**	**29**	**53**	**18**	**0**	**54**

[1] Only offshore pipeline installation activities have the potential to affect only mid-shelf stratum species (i.e., dwarf/pygmy sperm whales, rough toothed dolphins).

Table 6-5 summarizes Level B incidental take for a single SRV visit to the Port. No take is expected from regasification operations arising from a single SRV visit. Each SRV maneuvering/docking activity is expected to produce Level B behavioral modification to several Atlantic spotted and bottlenose dolphins. Use of thrusters by the SRV during maneuvering and docking represents a significant, albeit short-term, noise source, with the 120 dB isopleth at 3.6 kilometers from the SRV. Maneuvering and docking is expected to require 10 to 30 minutes to complete.

Take estimates for these SRV movements vary on a seasonal basis, with highest takes to be realized in spring and fall and lowest takes expected in winter and summer. Level B incidental take (i.e., potential behavioral modification) estimates for a single SRV visit can be summarized as follows:

- SRV Maneuvering and Docking
  - 9 to 31 marine mammals will realize Level B take, depending on season,
  - Highest take numbers are expected in fall, when 9 Atlantic spotted dolphins and 22 bottlenose dolphins will experience behavioral modification, and
  - Lowest take numbers are expected in summer, where 2 Atlantic spotted dolphins and 7 bottlenose dolphins will be taken.
- Regasification
  - No take is expected from regasification operations.

During the first year of operation, Port Dolphin expects to process 400 million bcf of natural gas, with an expected total of 46 SRV visits. SRV visitation is expected to include the following:

- Winter and summer: 12 visits per season; and
- Spring and fall: 11 visits per season.

Total annual Level B incidental take resulting from all SRV visits over the year is summarized in **Table 6-6**. Of note in this annual analysis are regasification operations. On a single SRV visit basis, no Level B take was noted although a small fraction of an individual was calculated (**Table 6-7**). During the year, a total of 46 SRV visits are slated to occur. Using the seasonal estimate of visits noted above, the total take of bottlenose and Atlantic spotted dolphins was calculated by season and annual total was determined (**Table 6-8**). As a result, while no Level B take was evident for a single SRV regasification operation, the annual total of 46 regasification operations is expected to produce a cumulative take estimate of one bottlenose dolphin (i.e., 0.6953 rounded to 1 for bottlenose dolphin; 0.2667 rounded down to 0 for Atlantic spotted dolphin).

Level B incidental take estimates for annual Port Dolphin operations can be summarized as follows:

- SRV Maneuvering and Docking
  - A maximum of 878 marine mammals will realize Level B take during the year associated with SRV maneuvering and docking at Port Dolphin, with lower numbers expected during those periods where full thruster output is not required,
  - Bottlenose dolphin will realize the highest take numbers, with 632 individuals expected to experience behavioral modification, and
  - Atlantic spotted dolphin will realize lowest take numbers, with 246 individuals expected to experience behavioral modification.
- Regasification
  - A maximum of one bottlenose dolphin is expected to realize potential behavioral modification during the year as a result of regasification operations.

Table 6-5 Summary of Level B Incidental Take (Potential Behavioral Modification) for Port Dolphin Operations – Single SRV Maneuvering/Docking and Regasification, by Season

Season	Species	SRV Maneuvering/ Docking[1]	Regasification[1]	Total	Single Visit Total, by Season
Winter	Atlantic spotted dolphin	2	0	2	11
	Bottlenose dolphin	9	0	9	
Spring	Atlantic spotted dolphin	9	0	9	27
	Bottlenose dolphin	18	0	18	
Summer	Atlantic spotted dolphin	2	0	2	9
	Bottlenose dolphin	7	0	7	
Fall	Atlantic spotted dolphin	9	0	9	31
	Bottlenose dolphin	22	0	22	

[1] Operations at the Port Dolphin Deepwater Port will affect only nearshore stratum species (i.e., Atlantic spotted and bottlenose dolphins).

Table 6-6 Summary of Annual Level B Incidental Take (Potential Behavioral Modification) for Port Dolphin Operations Based on 46 SRV Visits per Year

Season	Species	Single Visit Take		Seasonal Take Total - All SRV Visits		Annual Take Totals By Season
		SRV Maneuvering/ Docking	Regasification	SRV Maneuvering/ Docking	Regasification	
Winter	Atlantic spotted dolphin	2	0	24	0	132
	Bottlenose dolphin	9	0	108	0	
Spring	Atlantic spotted dolphin	9	0	99	0	297
	Bottlenose dolphin	18	0	198	0	
Summer	Atlantic spotted dolphin	2	0	24	0	108
	Bottlenose dolphin	7	0	84	0	
Fall	Atlantic spotted dolphin	9	0	99	0	341
	Bottlenose dolphin	22	0	242	0	
Annual Total Take, by Activity				**878**	**1**	
Annual Total Level B Take (Potential Behavioral Modification), All Port Dolphin Operations						**879**

Table 6-7 Calculation of Level B Take for Regasification during a Single SRV Visit, by Season

Estimated Take from Regasification (Number of Individuals), Single SRV Visit				
Species	Winter	Spring	Summer	Fall
Atlantic spotted dolphin	0.002036	0.009762	0.002292	0.009762
Bottlenose dolphin	0.009908	0.019962	0.007482	0.024281

Table 6-8 Calculation of Level B Take for Regasification during All SRV Visits, by Season and Annual Total

Estimated Take from Regasification (Number of Individuals), All Visits					
Species	Winter	Spring	Summer	Fall	Annual
Atlantic spotted dolphin	0.024432	0.107382	0.027504	0.107382	0.266700
Bottlenose dolphin	0.118896	0.219582	0.089784	0.267091	0.695353

6.5 SUMMARY OF INCIDENTAL TAKE

6.5.1 Construction and Installation Activities

No Level A take is expected from Port construction and installation activities. Sound from nearly all of the eight Port Dolphin construction and installation activities is expected to result in some degree of Level B harassment (i.e., potential behavioral modification). Four of the eight construction and installation activities are scheduled to occur within a single season – summer. HDD drilling, slated for summer, will not produce any behavioral modifications. While the SPL from this source is >150 dB, the 120 dB threshold is reached within 240 m of the drill; based on seasonal marine mammal densities and the small predicted area to be ensonified to a level >120 dB, no Level B take is expected. During buoy installation, a total of 6 individuals will be taken (2 Atlantic spotted; 4 bottlenose). During offshore hammering, a total of 7 individuals will be taken (2 Atlantic spotted; 5 bottlenose). During HDD vibratory driving, a total of 54 individuals will be taken (13 Atlantic spotted; 41 bottlenose).

The window for four of the remaining construction and installation activities (i.e., offshore pipeline laying, inshore pipeline laying, offshore plowing, and inshore plowing) extends across portions of two or three seasons, although each activity is expected to be completed within a single season. Given this scheduling uncertainty, take estimates have been calculated for each season during which the activity may occur.

For pipeline installation offshore, scheduled to occur during either late summer, fall, or early winter, a total of 19 individuals (summer: 4 Atlantic spotted; 15 bottlenose), 66 individuals (fall: 19 Atlantic spotted; 47 bottlenose), or 23 individuals (winter: 4 Atlantic spotted; 19 bottlenose) will be taken.

During pipeline installation inshore, scheduled to occur during either late summer, fall, or early winter, a total of 12 individuals (summer: 3 Atlantic spotted; 9 bottlenose), 42 individuals (fall: 12 Atlantic spotted; 30 bottlenose), or 15 individuals (winter: 3 Atlantic spotted; 12 bottlenose) will be taken.

During offshore plowing for the pipeline, scheduled to occur during either fall or winter, either 83 individuals (fall: 24 Atlantic spotted; 59 bottlenose) or 29 individuals (winter: 5 Atlantic spotted; 24 bottlenose) will be taken.

During inshore plowing, scheduled to occur during either fall or winter, a total of 53 individuals (fall: 15 Atlantic spotted; 38 bottlenose) or 18 individuals (winter: 3 Atlantic spotted; 15 bottlenose) will be taken.

If inshore and offshore pipelaying and inshore and offshore plowing activities are all completed during the fall season, behavioral disruption to as many as 70 Atlantic spotted dolphins and 174 bottlenose dolphins (total take, fall season: 244 individuals) may occur. If inshore and offshore pipelaying and inshore and offshore plowing activities are all completed during the winter, these activities may cause behavioral disruption to as many as 15 Atlantic spotted dolphins and 70 bottlenose dolphins (total take, winter season: 85 individuals). During the spring season, no construction or installation activities are expected; therefore, no incidental take is predicted for this season (total take, spring season: 0 individuals). If offshore and inshore pipeline installation activities are all completed during the summer, when coupled with offshore hammering, buoy installation, and HDD vibratory driving, a total of 24 Atlantic spotted dolphins and 74 bottlenose dolphins may realize behavioral disruption (total take, summer season: 98 individuals).

6.5.2 Port Dolphin Operations

During the first several years of operation, Port Dolphin expects to process 400 million bcf of natural gas, with an expected total of 46 SRV visits. This throughput level is expected to be maintained between 2013 and 2016, at which time an increase in throughput may be realized. In the event that an increase in the throughput is realized, Port Dolphin will request any needed modification in the permit at that time. The following summary is based on 46 SRV visits per year.

No Level A take is expected from Port operations. Sounds from Port Dolphin operations, including SRV maneuvering/docking and regasification, will produce seasonally variable Level B incidental take. SRV maneuvering and docking will result in Level B harassment to 878 marine mammals, including 632 bottlenose dolphins and 246 Atlantic spotted dolphins. Regasification operations produce low sound levels. On an annual basis, a single bottlenose dolphin incidental take is expected from regasification; no Level B take is expected for Atlantic bottlenose dolphins arising from regasification operations on an annual basis. Bottlenose dolphins are expected to realize the highest Level B take numbers from Port operations due to their relative abundance in the project area compared to Atlantic spotted dolphins.

7.0 Effects to Marine Mammal Species or Stocks

This section addresses the NFMS requirement to characterize the effects of the incidental take arising from the proposed activity on marine mammal species and stocks.

In general, the potential effects of noise on marine mammals include one or more behavioral or physiological responses, including masking, behavioral disturbance, hearing impairment (e.g., temporary threshold shift [TTS] or permanent threshold shift [PTS]), and non-auditory physiological effects. These effects are summarized below; additional details regarding noise effects on marine mammals are provided in **Appendix C**.

- **Masking** – interference with the ability of an animal to simultaneously detect meaningful signals, due to the presence of another sound, often at a similar frequency. While masking is a natural phenomenon to which marine mammals must be adapted, the introduction of strong sound into the sea at frequencies important to marine mammals will inevitably increase the severity and the frequency of occurrence of masking (JASCO, 2008). High levels of noise generated by anthropogenic activity may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking would be more prominent for lower frequencies.
- **Disturbance** – manifested in several different ways, including subtle changes in behavior, more conspicuous dramatic changes in activity patterns, and displacement. Behavioral reactions to sound by marine mammals are difficult to predict because they are dependent on numerous factors including species, state of maturity, experience, current activity, reproductive state, time of day, and weather state. If a marine mammal does react to an underwater sound by changing its behavior or moving a small distance, the impacts of that change may not be important to the individual, the stock, or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be important.
- **Hearing Impairment** – adverse effects upon a marine mammal's hearing from sound exposure may be temporary or permanent. The minimum sound level necessary to cause permanent hearing impairment (i.e., PTS) is higher, by a variable and generally unknown amount, than the level that induces barely detectable temporary hearing loss or TTS. The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage. TTS is the mildest form of hearing impairment and is defined as the reversible elevation in auditory threshold that may occur following overstimulation by a loud sound. PTS is the more severe form of hearing impairment and is defined as the irreversible or permanent increase in the threshold of hearing at a specific frequency (above a previously established reference level).
- **Non-Auditory Physiological Effects** – a suite of physiological effects resulting from noise exposure, including stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strongly pulsed sounds, particularly at higher frequencies. None of the activities associated with the Port Dolphin project will generate sounds loud enough to cause physiological effects.

Disturbance is expected to be the primary effect of both construction and operation sounds associated with Port Dolphin.

Construction and operation of Port Dolphin will occur sequentially (i.e., there will be no overlap between construction and port operations). Construction activities in the field are expected to occur over an 11-month period, with sound from pipeline construction causing potential disturbance to a small number of toothed whales. The short-term installation activities involving pile driving (i.e., anchor installation) will produce the most significant sources of sound during the construction period. Mitigation measures to be implemented will reduce the potential for noise-related harassment to marine mammal species present.

During the operational life of the project, marine mammals will be exposed to periodic continuous sound from SRV maneuvering/docking and regasification operations. During regasification, sound levels fall below the NMFS 120 dB re 1µPa disturbance criterion for continuous sound, as applicable to cetaceans, within 170 m of the source. On an annual basis, only a single bottlenose dolphin is expected to be disturbed during regasification.

Sounds associated with maneuvering and docking, however, have the potential to disturb a greater number of marine mammals near the Port. The underwater sound generated by use of the thrusters during maneuvering and docking would not result in any important effects to individuals or constitute a population-level harassment threat to local marine mammal stocks for the following reasons:

- Short duration and infrequency of the use of thrusters (approximately every 8 days; 10 to 30 minutes each episode for maneuvering);
- Relatively small but unknown amount of exposure;
- Fixed location of the sound sources; and
- Biological considerations, including the patchy distribution of toothed whales in the Port area.

Sounds from construction and operation of Port Dolphin will have minor effects on strategic stocks of bottlenose dolphins. Based on the sound exposures predicted, behavioral disruption to a number of bottlenose dolphins is expected. No adverse effects of sufficient magnitude (i.e., alteration of stock size or stock health) are expected from Port Dolphin sound sources.

8.0 Minimization of Adverse Effects to Subsistence Uses

This section addresses the NFMS requirement to identify methods to minimize adverse effects of the proposed activity on subsistence uses. There are no traditional subsistence hunting areas in the vicinity of Port Dolphin, and there are no activities related to the proposed Port that may affect the availability of a species or stock of marine mammals for subsistence uses. Consequently, there are no available methods to minimize potentially adverse effects to subsistence uses.

9.0 Effects to Marine Mammals from Loss or Modification of Habitat and the Likelihood of Restoration

This section addresses the NFMS requirement to characterize the short- and long-term impacts of the proposed activity on marine mammals associated with the predicted loss or modification of habitat and to address available methods and likelihood of restoration of lost or modified habitat. While final environmental impact determinations included minor to moderate, short-term, adverse impacts and minor, long-term, adverse impacts on biological resources of the project area, including marine mammals that may be present, potential impacts to marine mammal habitat must also be considered. No significant short- or long-term impacts on marine mammals or their habitat were noted during the environmental analysis. A complete discussion of the short- and long-term impacts is presented in the Port Dolphin FEIS (U.S. Maritime Administration and U.S. Coast Guard, 2009). While the complete FEIS discussion is not repeated in this IHA/LOA, it has been incorporated by reference. Specifically, impacts analysis pertinent to listed and non-listed marine mammals can be found in Sections 4.2.1.2 and 4.2.1.7, respectively, of the Port Dolphin FEIS. Noise analysis and impacts discussion for construction and operation is presented in FEIS Sections 4.8.1.1 and 4.8.1.2, respectively. Impacts to marine mammal habitat (i.e., pelagic and benthic environments, including potential prey) are addressed in FEIS Sections 4.1 (Water Resources [water quality]), 4.2.1.6 (Benthic Resources), 4.2.1.11 (Planktonic Fish and Invertebrates), and 4.2.1.13 (Essential Fish Habitat). Best management practices, mitigation and minimization measures, and monitoring, including discussions pertinent to marine mammals, pelagic habitats, and benthic habitats, is presented in FEIS Section 4.11.

Predicted impacts to marine mammal habitat have been summarized in the following sections. NMFS also provided comments following their review of the DEIS, indicating their concurrence that there would be no significant impacts on marine mammal habitat resulting from Port installation and construction activities or Port operations.

9.1 SHORT-TERM IMPACTS

Construction activities for Port Dolphin and the associated pipeline into Tampa Bay have the potential to affect marine mammal habitat in mainly two ways. The primary impacts are expected to be:

- Seafloor disturbance from anchor installation and pipelaying, temporarily affecting local turbidity (FEIS Section 4.1.1) and local soft and hard bottom communities (FEIS Section 4.2.1.6); and
- Increases in ambient noise levels from construction activities (FEIS Section 4.8.1.1).

Seafloor disturbance will produce minor, localized impacts to the benthic community. Construction and installation activities will temporarily disturb 1,222 hectares (3,020 acres) of seafloor at the Port and along the pipeline route (**Table 9-1**). More than 87% of total area affected results from anchor cable sweep, with the remaining area affected by plowing and mattress placement (during pipeline installation), barge anchoring, and other anchoring activity. Of the proposed construction activities, pipeline installation (including trenching, plowing, and backfilling, with associated anchor cable sweep) is expected to produce the greatest amount of sediment disturbance.

Table 9-1 Summary of Benthic Area Affected by Installation Activities

<table>
<tr><th rowspan="3">Activity</th><th colspan="5">Area Affected
acres (hectares)</th></tr>
<tr><th colspan="2">State Waters</th><th colspan="2">Federal Waters</th><th rowspan="2">Total by Activity</th></tr>
<tr><th>Hard/
Live Bottom</th><th>Sand/
Soft Bottom</th><th>Hard/
Live Bottom</th><th>Sand/
Soft Bottom</th></tr>
<tr><td>Plowing</td><td>20.03 (8.11)</td><td>154.81 (62.65)</td><td rowspan="2">94.12 (38.09)</td><td rowspan="2">57.75 (23.37)</td><td rowspan="2">329.87 (133.5)</td></tr>
<tr><td>Mattress/rock armoring placement</td><td>0.0 (0.0)</td><td>3.16 (1.28)</td></tr>
<tr><td>Dredge</td><td>0.24 (0.10)</td><td>1.28 (0.52)</td><td>--</td><td>--</td><td>1.52 (0.62)</td></tr>
<tr><td>Anchoring</td><td>1.48 (0.6)</td><td>9.60 (3.88)</td><td>5.56 (2.25)</td><td>3.95 (1.60)</td><td>20.59 (8.33)</td></tr>
<tr><td>Anchor cable sweep</td><td>255.22 (103.28)</td><td>1,717.19 (694.92)</td><td>399.91 (161.84)</td><td>273.47 (110.67)</td><td>2,645.76 (1,070.71)</td></tr>
<tr><td>STL buoy system installation</td><td>--</td><td>--</td><td>0.10 (0.04)</td><td>0.50 (0.19)</td><td>0.60 (0.23)</td></tr>
<tr><td>STL mooring line sweep</td><td>--</td><td>--</td><td>6.39 (2.58)</td><td>15.71 (6.36)</td><td>22.1 (8.94)</td></tr>
<tr><td colspan="5">Total</td><td>3,020.44 (1,222.33)</td></tr>
</table>

STL = submerged turret loading.

Turbidity increases will produce minor, localized, and short-term impacts to water quality. The total areal extent of turbidity plumes created during pipeline installation would be approximately 1,894 hectares (4,679 acres). Habitats along the plowable portions of the pipeline route are composed of 65% soft bottom and 35% hard bottom. Turbidity associated with the anchor and pipeline installation is expected to be temporary, settling within hours of the cessation of installation activities. Under worst-case conditions, it is estimated that sediment concentrations in the water column would exceed 100 mg/L for less than 3 hours in Tampa Bay and less than 2 hours offshore.

A variety of impact producing factors – noise, discharges, physical presence, lights, and turbidity – with potential to adversely affect marine mammal prey availability may be expected as a result of Port construction and installation activities. Both Atlantic spotted and bottlenose dolphins feed on various pelagic and benthic fish species and squid; bottlenose dolphins are also known to feed on various sharks, rays, and shrimp.

During construction, underwater noise levels will increase temporarily. Construction-related noise is expected to illicit a startle response in fish and squid. Elevated noise levels may also cause some species to leave the immediate area of construction operations. Displaced individuals are expected to return shortly after construction is completed.

Discharges will be localized near their source and are not expected to adversely affect fish or squid. While the physical presence of construction vessels will produce avoidance behavior, night lighting may serve to attract fishes and squid; neither physical presence nor night lighting are expected to adversely these prey species. The detectability of prey may be limited within turbidity plumes created by anchor and pipeline installation. However, these plumes are expected to be localized and temporary, settling within hours of the cessation of installation activities. No short-term impacts to potential prey items (fishes, squid) are expected from construction activities.

Construction activities will not create long-term habitat changes. Any marine mammals displaced by seafloor disturbance are expected to return shortly after the construction activity has been completed. Marine mammals could be indirectly affected by disturbance-related changes in benthic prey availability. Loss or displacement of prey species is expected to be short term; affected benthic species, representing a small fraction of available food resources in the project area, are expected to recover soon after construction has ceased.

9.2 LONG-TERM IMPACTS

Operation of the Port Dolphin DWP has the potential to result in limited long-term effects on the marine environment. Potential impacts are expected to include continued disturbance of the seafloor, withdrawal and discharge of cooling water, and generation of underwater noise.

- Seafloor Disturbance: Anchors, PLEMs, and exposed portions of the pipeline and concrete mattresses or rock armoring will be permanent modifications to the seafloor (FEIS Section 4.2.1.6). The placement of buoy system parts and concrete mattresses or rock armoring along the pipeline route, as well as STL buoy anchor sweep, will produce long-term disturbance of 10 hectares (24.7 acres) of soft bottom habitat and 4.4 hectares (10.9 acres) of hard bottom habitat. STL buoy anchor sweep represents the single largest mechanism for long-term disturbance, affecting 6.4 hectares (15.7 acres) of soft substrate/sand habitat and 2.6 hectares (6.4 acres) of hard bottom substrate. Colonization of disturbed bottom areas is expected to occur; however, the recovery period is difficult to predict, ranging from months to years. Newly created hard bottom surfaces and disturbed hard bottom areas will be colonized more slowly than disturbed soft bottom areas
- Cooling Water Withdrawal and Discharge: During operations, cooling water withdrawals and discharges could have several impacts on water quality near the DWP (FEIS Section 4.1.1.2). Potential impacts may include increased water temperature, increased turbidity, and decreased dissolved oxygen content.
- Underwater Noise: During the operations of the DWP, underwater noise will be produced during SRV maneuvering/docking and regasification (FEIS Section 4.8.1.2). The most significant noise sources are the maneuvering thrusters to be employed during docking. Thruster use will be intermittent, with frequency of use and the number of thrusters required depending on ambient oceanographic and meteorological conditions. Use of thrusters, coupled with the fixed location of occurrence, will not result in significant effects to individual marine mammals.

As was noted previously for short-term impacts associated with construction activities, a variety of impact producing factors – noise, discharges, physical presence, and lights – have the potential to adversely affect marine mammal prey availability as a result of Port operations.

During maneuvering/berthing and regasification, underwater noise levels will increase. Operations-related noise is expected to illicit a startle response in fish and squid. Elevated noise levels may also cause some species to leave the immediate area.

Discharges will be localized near their source and are not expected to adversely affect prey species. While the physical presence of the SRV will produce avoidance behavior, night lighting may serve to attract fishes and squid; neither physical presence nor night lighting are expected to adversely affect prey species. No long-term impacts to potential prey items (fishes, squid) are expected from Port operations.

10.0 Effects of Habitat Loss or Modification on Marine Mammals

This section addresses the NFMS requirement to characterize the short- and long-term impacts of the proposed activity on predicted habitat loss or modification. Loss or modification of marine mammal habitat could arise from alteration of benthic habitat, degradation of water quality, and effects of noise. These impacts could be short- or long-term in nature. No significant short- or long-term impacts on marine mammals or their habitat were noted during the environmental analysis. A complete discussion of the short- and long-term impacts is presented in the Port Dolphin FEIS (U.S. Maritime Administration and U.S. Coast Guard, 2009). As noted previously, the complete FEIS discussion is not repeated in this IHA/LOA. However, the predicted impacts to marine mammal habitat have been summarized in the following section. Impacts to marine mammal habitat (i.e., pelagic and benthic environments, including potential prey) are addressed in FEIS Sections 4.1 (Water Resources [water quality]), 4.2.1.6 (Benthic Resources), 4.2.1.11 (Planktonic Fish and Invertebrates), and 4.2.1.13 (Essential Fish Habitat). Best management practices, mitigation and minimization measures, and monitoring, including discussions pertinent to marine mammals, pelagic habitats, and benthic habitats, is presented in FEIS Section 4.11. NMFS also provided comments following their review of the DEIS, indicating their concurrence that there would be no significant impacts on marine mammal habitat resulting from Port installation and construction activities or Port operations.

10.1 SHORT-TERM IMPACTS

Short-term impacts on benthic communities will occur during the installation of the Port and offshore pipeline. Proposed construction activities will temporarily disturb 1,222 hectares (3,020 acres) of seafloor at the Port and along the pipeline route. Pipeline installation (plowing, backfill) will produce suspension of fine sediments and resettlement of suspended sediments in the area immediately adjacent to ongoing construction operations. Resettlement of suspended sediments will produce localized reductions in benthic growth, reproduction, and survival rates of indigenous fauna; if the resettlement is significant, smothering of benthic flora and fauna may occur.

Recovery of soft bottom benthic communities adversely affected by Port construction is expected to take a period of weeks to several years. Displaced organisms will return shortly after construction ceases, while disrupted communities will recolonize from the adjacent soft bottom communities. Disturbance to hard bottom communities will be followed by recolonization, but at a slower rate than that expected in soft bottom areas. Overall, short-term impacts to benthic communities that may support fishes utilized by marine mammals will be localized. No significant short-term impacts to marine mammal habitat are expected, either through loss or modification.

10.2 LONG-TERM IMPACTS

Operations activities would cause long-term disturbances in both soft and hard bottom habitats. The placement of STL buoy system parts and concrete mattresses or rock armoring along the pipeline route, as well as STL buoy anchor sweep, will produce long-term disturbance of 10 hectares (24.7 acres) of soft bottom habitat and 4.4 hectares (10.9 acres) of hard bottom habitat. STL buoy anchor sweep represents the single largest mechanism for long-term disturbance, affecting 6.4 hectares (15.7 acres) of soft substrate/sand habitat and 2.6 hectares (6.4 acres) of hard bottom substrate. Overall, long-term impacts to soft and hard bottom habitat that may support fishes utilized by marine mammals will be relatively small and localized. No significant long-term impacts to marine mammal habitat are expected, either through loss or modification.

11.0 Methods to Reduce Impact to Species or Stocks

This section addresses the NMFS IHA/LOA requirement to assess the availability and feasibility (economic and technological), methods, and manner of conducting such activity or means of effecting the least practicable impact upon affected species or stock, their habitat, and of their availability for subsistence uses, paying particular attention to rookeries, mating grounds, and areas of similar significance. Marine mammals most likely to occur in the project area include Atlantic spotted and bottlenose dolphins at the Port and between the Port and shore, and manatees within protected nearshore waters.

Port Dolphin Energy LLC has committed to a comprehensive set of mitigation measures during construction and operation of the Port, including the following:

- Visual monitoring program (marine animal watch);
- Acoustic disturbance mitigation measures (during pile driving activities);
- Vessel strike avoidance measures for manatees and cetaceans;
- Line and cable entanglement avoidance measures; and
- Marine debris and waste management protocols.

Elements of the visual monitoring program, acoustic disturbance mitigation, and vessel strike avoidance are detailed in the following text. Complete details of the proposed mitigations are discussed in the Marine Protected Species Management Plan for Offshore Construction of the Port Dolphin Energy LLC Deepwater Port, which is included as **Appendix B** of this application.

11.1 VISUAL MONITORING PROGRAM (MARINE ANIMAL WATCH)

Visual monitoring personnel, termed Protected Species Observers (PSOs), will be instructed in surveying for protected species (as outlined in **Appendix B**, Marine Protected Species Management Plan) and specific data recording methods and will be familiar with species that may potentially occur in the area. For the purposes of this IHA/LOA, protected species will include those marine mammal species that may occur in the project area. PSO applicants for this project will be approved in advance by the Florida Fish and Wildlife Commission (FWC) and the National Marine Fisheries Service, Office of Protected Resources (NMFS, OPR) prior to service.

At least two PSOs will be on watch for at least 30 minutes prior to the start-up of construction-related activities. PSOs on duty during daylight hours (dawn to dusk) will look for marine mammal species using the unaided eye and hand-held binoculars. PSOs will stand watch in a suitable location that affords the observers an optimal view of the sea surface and will not interfere with operation of the vessel or in-water activities. The PSOs will provide 360° coverage surrounding the work vessel and adjust their positions appropriately to ensure adequate coverage of the entire ZOI. The limits of the designated ZOI will be determined using binocular reticle or other equipment such as an electronic rangefinder or range stick. Observations must be consistent, diligent, and free of distractions for the duration of the watch. PSOs will be on watch at all times during daylight hours when in-water operations are being conducted, unless conditions (e.g., fog, rain, and darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit. While activities will be permitted during deteriorating conditions, they 1) must have been initiated following proper clearance of the ZOI under acceptable observation conditions; and 2) must be restarted, if halted for any reason, using the appropriate ZOI clearance procedures.

If a marine mammal species is observed, the PSO will note and monitor the position (including relative bearing and estimated distance to the animal) until the animal dives or moves out of visual range of the observer. The PSO will continue to observe for additional animals that may surface in the area; often, there are numerous animals that may surface at varying time intervals. Any time a marine mammal species is observed within the designated ZOI, the PSO will call for the immediate shut-down of in-water operations. Each PSO will be provided with a two-way radio dedicated to marine animal watch-related communication between the PSO and field operations manager. Any shut-down of activities due to a marine mammal species sighting within the ZOI must be maintained until the sighted animal(s) has exited the ZOI or (if the sighted animal[s] dive) for a period of 30 minutes.

Records will be maintained of all marine mammal species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the pile, direction and heading in relation to the pile driving, and behavioral observations. When animals are observed in the impact zone, additional information and corrective actions taken, such as a shutdown of the pile driver, duration of the shutdown, behavior of the animal, and time spent in the safety zone, will be recorded. The PSOs also will identify and record large schools of fish, marine mammals, mats of the floating alga *Sargassum*, jellyfish aggregations, or other indicators of a biologically productive area. During pile-driving activities, data regarding the types of piles driven (e.g., material construction, diameter and length of pile, and wall thickness), type and power of the hammer used, number of cold starts, strikes per minute, and duration of the pile-driving activities will be recorded.

In the unanticipated event of a take of a listed species, re-initiation of consultation with NMFS Protected Resources Division is required. If a take of a listed species occurs from pile-driving activities, a report of the incident will be submitted NMFS' Protected Resources Division. All other dead or injured marine mammal species will be reported to the marine mammal stranding hotline or to local stranding network contacts. All other dead or injured marine mammal species incidents will be reported to NMFS' Southeast Regional Office.

11.2 ACOUSTIC DISTURBANCE MITIGATION MEASURES

The following impact mitigation measures will be implemented to reduce potential acoustic impacts to marine mammal species during pile-driving activities:

- Vessel crew and contractors would be requested to use equipment and procedures that minimize noise. The use of enclosures and mufflers on equipment would be a viable option as well as minimizing the use of thrusters. Sound-muffling devices or engine covers will be used where appropriate, and engines and equipment will be turned off when not in use.
- During pile-driving activities, the power of impact hammers will be reduced to minimum energy levels required to drive a pile, thus reducing the amount of noise produced in the marine environment.
- All vessel crew members and contractors would be requested to "ramp-up" (also known as "soft start" or "slow build up"), which entails the gradual increase in intensity of a sound source. Ramping up involves slowly increasing the power of the hammer and noise produced over the ramp-up period. In this case, "dry firing" of a pile-driving hammer is a method of raising and dropping the hammer with no compression of the pistons, producing a lower-intensity sound than the full power

of the hammer. The intent of a ramp-up is to either avoid or reduce the potential for instantaneous hearing damage (from the sudden initiation of an acoustic source at full power) to an animal that might be located in close proximity. The intent of gradually increasing the sound levels of a sound source is to warn animals of pending acoustic operations and to allow sufficient time for those animals to leave the immediate area.

- To minimize excessive noise, engines on all equipment and vessels will be maintained in accordance with manufacturer's recommendations.
- Pile driving may continue into nighttime hours only if ramp-up/dry firing protocols have been conducted during daylight hours. In the event of a shutdown at night, the air hammer cannot be restarted until daylight visual monitoring activities are resumed.

During daylight hours, a 250-meter ZOI will be established around a pile to be monitored – a 200-meter radius to the 160-dB isopleth, plus an additional 50-meter watch zone. The PSO will monitor the 250-meter ZOI to prevent or minimize potential adverse impacts to marine mammal species. The 250-meter ZOI will be observed for marine mammal species for at least 45 minutes prior to initiating all pile-driving activities (i.e., each time a hammer is started). Each time a pile driving hammer is started, dry firing or ramping up of the hammer will be conducted for at least 15 minutes to allow animals the opportunity to leave the area. The 45-minute observation period may occur during dry firing and ramping up of the pile-driving hammer (i.e., observations may begin 30 minutes prior to dry firing or ramp-up). Pile driving will be stopped if any marine mammal species are sighted within the ZOI or a marine mammal species is observed moving toward the ZOI. The on-site construction manager must comply immediately with such a call by an on-watch PSO. Any disagreement or discussion should occur only after shut-down. Pile driving will not restart until the animal is confirmed to be outside of the ZOI. If at any time a marine mammal species is observed in the ZOI during dry firing or ramp-up, the hammer will be shut down until the animal has left the ZOI of its own volition; ramp-up procedures will then be repeated. Visual monitoring during nighttime activities will consist of monitoring the area illuminated by work lights. Ramp up will not occur during the night.

Other Offshore Construction Activities

Other offshore construction activities include siting the STL buoys and associated equipment and laying the marine pipeline. During daylight operations, a 100-meter ZOI will be established around the construction vessel to be monitored, which the PSO will monitor to prevent or minimize potential adverse impacts to marine mammal species. Personnel associated with the project will undergo a briefing of the potential presence of marine mammal species in the project area and harm avoidance and other mitigation requirements. All construction personnel will observe water-related activities for the presence of these species. If a marine mammal species is seen within the ZOI, all appropriate precautions will be implemented to ensure its protection, including cessation of operation of any moving equipment within 91 meters of a marine mammal species. Activities may not resume until the animal has departed the project area of its own volition.

Construction activities may continue into nighttime hours. Visual monitoring will be limited to areas illuminated by the construction vessel(s). Ramp up will not occur during the night.

11.3 VESSEL STRIKE AVOIDANCE

For cetaceans, the following cetacean vessel strike mitigation measures for active installation/decommissioning vessel operations will be implemented during project activities:

- Construction or support vessel vessels, while underway, would remain 91 meters from all cetaceans to the extent possible.
- If a cetacean is within 15 meters of a construction or support vessel underway, all operations will cease until it is >91 meters from the vessel. If the cetacean is within 91 meters of an active construction or support vessel underway, it will be observed and the vessel will cease power to the vessel propellers as long as sea conditions permit for safety. After the cetacean leaves the area the vessel will proceed with caution, following the guidelines below:
  - Resume vessel at slow speeds,
  - Stay on parallel course with the cetacean – follow behind or next to at an equal or lesser speed,
  - Do not cross the path of the whale,
  - Do not attempt to steer or direct the cetacean away,
  - If a cetacean exhibits evasive or defensive behavior, stop the vessel until the cetacean has left the immediate area, and
  - Do not allow the vessel to come between a mother and her calf.
- If a sighted cetacean is believed to be a North Atlantic right whale, Federal regulation requires a minimum distance of 457 meters from the animal be maintained (50 CFR 224.103 (c)).
- Practical speeds will be maintained to the extent possible. Guidelines for speeds include the following:
  - No wake/idle speeds where the draft of the vessel provides less than a 4-foot (1.2-meter) clearance from the bottom. All vessels would follow routes of deep water whenever possible,
  - All construction vessels transiting to and from the port from shore would not exceed 14 knots during regular operations as most collisions causing lethal or severe injuries involve vessels moving at 14 knots or faster,
  - Avoid sudden changes in speed and direction,
  - Speeds approaching and departing the buoys would be reduced to 10 knots maximum,
  - Speeds during installation would be well under 14 knots; vessel may be stationary during certain phases of installation, and
  - Higher speeds would only be used if safety reasons warrant.
- Members of the vessel crew would be encouraged to undergo NOAA Fisheries training prior to activity. Topics in the training course include reporting procedures, collision emergency procedures, and cetacean presence detection (surfacing near wake).
- During installation and decommissioning, lookouts are required to scan for surfacing cetaceans and report sightings to the Captain, who would notify the Environmental Coordinator.
- Offshore construction activities would be temporarily terminated if cetaceans were observed in the area and there is the potential for harm of an individual. The Environmental Coordinator would be called in to determine the appropriate course of action.
- During construction of the facility, an Environmental Coordinator would be on site and responsible for communicating with NOAA Fisheries Service and USFWS/FWC personnel, as appropriate.
- If a collision seems likely, emergency collision procedures will be followed.
- In the unlikely event a cetacean is struck, the FWC Law Enforcement and the USFWS in Tampa, Florida and/or the NOAA Fisheries Office for Law Enforcement will be notified.
- Injured, dead, or entangled right whales should be immediately reported to the U.S. Coast Guard (USCG) via VHF Channel 16.

11.4 LIGHTING

The following BMPs will be implemented to minimize the attraction of marine mammals to the project area and prevent potential impacts to protected species from nighttime lighting:

- Lighting will be down-shielded to prevent unnecessary upward illumination while illuminating the vessel decks only. They would not illuminate surrounding waters. Lighting used during all activities will be regulated according to USCG requirements, without using excessive wattage or quality of lights. Once an activity is completed, all lights used only for that activity would be extinguished.

Port Dolphin is committed to marine mammal strike avoidance and lighting BMPS with the implementation of appropriate vessel and lighting mitigation measures. While manatees are not addressed in this IHA/LOA, a detailed plan for vessel strike avoidance of manatees is presented in the Marine Protected Species Management Plan for Offshore Construction of the Port Dolphin Energy LLC Deepwater Port (**Appendix B**).

12.0 Potential for Subsistence Impacts

This section addresses the NMFS IHA/LOA requirement to identify the potential for impacts to subsistence activities. Specifically, where the proposed activity would take place in or near a traditional subsistence hunting area and/or potentially affect the availability of a species or stock of marine mammals for subsistence uses, the applicant must submit a plan of cooperation or information that identifies what measures have been taken and/or will be taken to minimize any adverse effects on the availability of marine mammals for subsistence use.

There are no traditional subsistence hunting areas in the vicinity of Port Dolphin, and there are no activities related to the proposed Port that may affect the availability of a species or stock of marine mammals for subsistence uses.

13.0 Monitoring and Reporting

This section addresses the NMFS IHA/LOA requirement to address:

1) the suggested means of accomplishing the necessary monitoring and reporting that will result in increased knowledge of the species; and
2) the level of taking or impacts on the population of marine mammals that are expected to be present while conducting activities and suggested means of minimizing burdens by coordinating such reporting requirements with other schemes already applicable to persons conducting such an activity.

NMFS also requires that monitoring plans include a description of the survey techniques that would be used to determine the movement and activity of marine mammals near the activity site(s), including migration and other habitat uses such as feeding.

The proposed Marine Protected Species Management Plan for Offshore Construction of the Port Dolphin Energy LLC Deepwater Port, included as **Appendix B** of this application, outlines monitoring and reporting requirements.

For the Visual Monitoring Program, records will be maintained of all marine mammal species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the pile or other noise producing activity, direction and heading in relation to the pile driving or other noise producing activity, and behavioral observations. When animals are observed in the impact zone, additional information and corrective actions taken (such as a shutdown of the pile driver or other noise source, duration of the shutdown, behavior of the animal, and time spent in the safety zone) will be recorded. The PSOs also will identify and record large schools of fish, marine mammals, mats of the floating alga *Sargassum*, jellyfish aggregations, or other indicators of a biologically productive area. During pile-driving activities, data regarding the types of piles driven (e.g., construction, diameter and length of pile, and wall thickness), type and power of the hammer used, number of cold starts, strikes per minute, and duration of the pile-driving activities will be recorded. For other select noise producing activities (e.g., SRV docking, HDD drilling, and HDD vibratory driving), data regarding the nature of the sound source will be recorded (e.g., engines or vessels operating, duration of noise producing activity) and empirical measurements will be taken for a one-time event to verify modeled radii.

In the unanticipated event of a take of a listed species, re-initiation of consultation with NMFS Protected Resources Division is required. If a take of a listed species occurs from pile driving activities, a report of the incident will be submitted NMFS' Protected Resources Division. All other dead or injured marine mammal species will be reported to the marine mammal stranding hotline or to local stranding network contacts. All other dead or injured marine mammal species incidents will be reported to NMFS' Southeast Regional Office.

14.0 Research Recommendations

This section addresses the NMFS IHA/LOA requirement to suggest means of learning of, encouraging and coordinating research opportunities, plans, and activities related to reducing such incidental taking and evaluating its effects.

No direct research on marine mammals or marine mammal stocks is expected from the Port Dolphin project. No underwater sound measurements will be acquired during construction or operational phases of the project. However, data acquired during the Visual Monitoring Program may provide valuable information to direct or refine future research on marine mammal species present in the area. Sighting data (e.g., date and time, weather conditions, species identification, approximate sighting distance, direction and heading in relation to sound sources, and behavioral observations) may be useful in designing the location and scope of future marine mammal survey programs.

During previous discussions with NOAA prior to issuance of the Final EIS, Port Dolphin was informed that a noise monitoring program would be required. Specific details of this monitoring program remain to be developed and approved. Results of the Port Dolphin noise monitoring program will be extremely useful to the research community, government regulators, and the private sector. Noise measurement data tied to specific activities would provide additional reference data for future noise modeling and noise characterizations (e.g., within future environmental impact assessments).

15.0 List of Preparers

The following individuals assisted in the preparation of the Port Dolphin IHA/LOA application:

Brian Balcom
Senior Scientist
CSA International, Inc.
Salinas, California

Dr. Neal Phillips
Senior Scientist
CSA International, Inc.
Philadelphia, Pennsylvania

Kimberley Olsen
Senior Scientist
CSA International, Inc.
Stuart, Florida

Stephen Viada
Senior Staff Scientist
CSA International, Inc.
Stuart, Florida

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Appendix A

Summary Sound Tables

Table A-1 Third-Octave Band Source Levels for Construction Modeling Scenarios (From: JASCO, 2008, 2010)

Freq (Hz)	Pile Driving[a]	Anchor Operations[b]	Pipe-laying[b]	Tug Anchor Pull[c]	Tug Half-Speed Transit[c]	Dredging[d]	HDD Drilling	HDD Vibratory Driving
	Source level (dB re 1 µPa)							
10	202	175.6	164.7	202.8	188.7	153	125.0	147.3
12.5	202	170	166.2	196.5	182.7	153	125.0	143.1
16	192	162.7	162.7	193.1	174.1	153	125.0	158.6
20	187	158.3	165.5	191.1	167.5	153	125.0	144.6
25	184	151.8	169	196.7	165.2	165	133.0	139.9
31.5	186	149.1	159.6	188.8	172.2	162	136.0	156.9
40	188	146.6	156.2	177.3	182.2	169	139.0	159.2
50	184	147.9	157.7	176.4	170.2	172	145.0	164.2
63	188	153.3	154.3	179.2	167.1	171	144.0	160.9
80	198	153.2	152.2	178.8	164.9	172	141.0	164.6
100	200	156.4	153	178.1	161.8	179	142.0	165.6
125	204	162.2	159.8	176.7	166	178	146.0	168.6
160	208	155.6	152.5	175.9	167.6	180	145.0	167.3
200	209.5	151.4	149.8	173.5	167.5	179	143.0	168.9
250	209	151.7	152.2	178.8	164.8	177	154.0	168.0
315	204	143.6	142.4	172.8	165.2	177	141.0	171.1
400	204.5	145.2	147.2	165.4	165.2	176	137.0	172.8
500	205	145.8	144.8	170.7	169.8	173	137.0	172.0
630	198	145.5	142.7	168.8	159.9	170	136.0	173.6
800	195	150.5	147.5	165.1	158.6	169	135.0	174.1
1,000	194	150.8	148.7	164.2	163.6	169	135.0	176.3
1,250	195	142.7	141.7	167.3	161	169	135.0	176.6
1,600	194	138.6	136.1	165.9	164.9	169	135.0	177.5
2,000	192	143.2	139.3	166.5	164.2	169	135.0	176.4
2,500	---	---	---	---	---	---	---	175.1
3,150	---	---	---	---	---	---	---	174.1
4,000	---	---	---	---	---	---	---	174.5
5,000	---	---	---	---	---	---	---	174.0
Broadband	216.2	177.2	173.9	205.2	190.8	187.7	156.9	186.4

Notes:

a. Source levels for the impact hammer estimated assuming a pulse length of 100 milliseconds from an MHU 3000 impact hammer.
b. Source levels for anchor operations and pipelaying operations estimated based on the Castoro II barge.
c. Source levels for tug anchor pull and half speed transit are based on the Britoil 51 tug.
d. Source levels for dredging are based on the Aquarius dredge.

Table A-2 Distances that 95% of the Noise Associated with Construction Would Travel (From: JASCO, 2008)

Sound Pressure Level (dB re 1µPa)	Buoy Installation	Impact Hammering	Pipe-Laying: Offshore	Pipe-Laying: Inshore
	Distance from Source (km)			
190	< 0.2	0.03	< 0.2	< 0.2
180	< 0.2	0.18	< 0.2	< 0.2
170	< 0.2	1.1	< 0.2	< 0.2
160	< 0.2	4.5	< 0.2	< 0.2
150	< 0.2	14.4	0.52	0.39
140	0.35	> 20	2	0.89
130	1.4	> 20	3.8	2.1
120	3.9	> 20	7.5	6.0

Table A-3 Third-Octave Band Source Levels for Operational Modeling Scenarios; Source Depth is 6 meters in all Cases (From: JASCO, 2008)

Frequency (Hz)	SRV, Half Speed Transit	SRV, Docking	SRV, docking, all 4 thrusters (not modeled)
10	162.4	171.5	172.7
12.5	162.4	171.5	172.7
16	162.4	171.5	172.7
20	162.4	171.5	172.7
25	162.4	171.5	172.7
31.5	162.4	171.5	172.7
40	162.4	171.5	172.7
50	162.4	171.5	172.7
63	162.4	171.5	172.7
80	162.4	171.5	172.7
100	162.4	171.5	172.7
125	160.5	169.6	170.7
160	158.4	167.4	168.6
200	156.4	165.5	166.7
250	154.5	163.6	164.7
315	152.5	161.6	162.7
400	150.4	159.5	160.6
500	148.5	157.5	158.7
630	146.5	155.5	156.7
800	144.4	153.5	154.6
1,000	142.4	151.5	152.7
1,250	140.5	149.6	150.7
1,600	138.4	147.4	148.6
2,000	136.4	145.5	146.7
Broadband	173.5	182.6	183.7

Source: Port Dolphin, 2009b.

Table A-4 Distance that 95% of the Shuttle Regasification Vessel Noise Would Travel Under Different Operational Scenarios (From: JASCO, 2008)

Sound Pressure Level (dB re 1 μPa)	Buoy Approach	Docking
	Distance from Source (km)	
190	---	---
180	---	< 0.01
170	< 0.01	< 0.01
160	< 0.01	0.01
150	0.01	0.09
140	0.09	0.37
130	0.43	1.5
120	1.7	3.6

Source: Richardson et al., 1995.

Table A-5 Estimate of 1-Octave Band Levels for Regasification on One Shuttle Regasification Vessel (From: JASCO, 2008)

Center Frequency	Source Level (dB re 1 μPa @1m)
31.5	131.8
63	135.5
125	139.2
250	143.0
500	146.5
1,000	148.9
2,000	151.2
Broadband	164.6

Source: Richardson et al., 1995.

Table A-6 95th Percentile Radii for Goal Post Installation by Drilling and by Vibratory Driving
Radii corresponding to Level A and Level B harassment criteria are shown in bold italics.
Model Resolution is 10 m (From: JASCO, 2010, Table 3)

SPL (dB re 1 μPa)	95th percentile radius (km)							
	Un-weighted		M_{lf}		M_{mf}		M_{pinn}	
	Drilling	Vibratory Driving	Drilling	Vibratory Driving	Drilling	Vibratory Driving	Drilling	Vibratory Driving
120	***0.24***	12.63	0.24	12.51	0.18	12.60	0.22	12.61
130	0.07	5.42	0.07	5.33	0.06	5.37	0.06	5.40
140	0.01	1.54	0.01	1.53	<0.01	1.53	0.01	1.54
150	<0.01	0.38	<0.01	0.37	<0.01	0.36	<0.01	0.37
160	<0.01	***0.07***	<0.01	0.07	<0.01	0.05	<0.01	0.06
170	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
180	***<0.01***	***<0.01***	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01

Appendix B

Marine Protected Species Management Plan for Offshore Construction of the Port Dolphin Energy LLC Deepwater Port

MARINE PROTECTED SPECIES MANAGEMENT PLAN
FOR OFFSHORE CONSTRUCTION OF THE
PORT DOLPHIN ENERGY LLC
DEEPWATER PORT

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1.0 INTRODUCTION

The proposed Port Dolphin deepwater port project extends through Tampa Bay, Florida to an offshore terminal approximately 28 nmi (45 km) offshore in approximately 100 ft (30 m) of water. Protected resources that are known to occur within the project area include marine mammals (cetaceans and the Florida manatee), marine and coastal birds, sea turtles, and the smalltooth sawfish. All marine mammal species are protected under the Marine Mammal Protection Act (MMPA), which prohibits, with certain exceptions, the "take" of marine mammals in U.S. waters. Sea turtles, the Florida manatee, and the smalltooth sawfish are listed as endangered or threatened species under the Endangered Species Act of 1973.

Impact-producing factors associated with the proposed liquid natural gas (LNG) construction project include the following:

- Vessel traffic (e.g., vessel strikes, physical disturbance, etc.);
- Water turbidity and discharges;
- Underwater noise;
- Artificial lighting;
- Debris (entanglement/ingestion); and
- Accidental fuel/oil spills.

This Protected Species Management Plan follows best management practices (BMPs) provided by the following: the National Oceanic and Atmospheric Administration (NOAA) Fisheries Service Protected Resources Division (St. Petersburg, Florida) for construction activities associated with the Port Dolphin LNG project; U.S. Fish and Wildlife List of Standard Manatee Conditions for In-Water Work (July, 2005); Florida Fish and Wildlife Commission (FWC) Manatee and Other Marine Animal Watch Information (http://myfwc.com/WildlifeHabitats/manatee_watch.htm); and, where applicable, U.S. Department of the Interior, Minerals Management Service (MMS) Implementations of Seismic Survey Mitigation Measures and Protected Species Observer Program (NTL No. 2007-G02 [February 7, 2007]). Proposed impact mitigation measures include a visual monitoring program (marine animal watch) (**Sections 2.0**, **3.1.2**, and **3.2**); acoustic disturbance mitigation measures during pile-driving activities (**Section 3.1**); and proposed protective measures to address vessel strike (**Section 3.3**), line and cable entanglement (**Section 3.4**), and marine debris (**Section 3.5**) concerns.

2.0 VISUAL MONITORING PROGRAM (MARINE ANIMAL WATCH)

The Port Dolphin project will implement a visual monitoring program as a primary mitigation measure to reduce or eliminate potential impacts to protected species from proposed in-water construction activities. The program will advise project personnel to cease in-water project activities when protected species are sighted within a designated exclusion zone (i.e., Zone of Influence [ZOI]). Details on specified ZOIs for pile-driving activities for submerged turret loading (STL) buoy installation and other offshore construction activities are presented in **Sections 3.1.2** and **3.2**, respectively. Visual monitoring personnel, termed Protected Species Observers (PSOs), will be instructed in surveying for protected species and specific data recording methods and be familiar with species that may occur in the area. PSO applicants for this project will be approved by the FWC prior to service.

PSOs on duty during daylight hours (dawn to dusk) will look for protected species using the unaided eye and hand-held binoculars. PSOs will stand watch in a suitable location that will not interfere with operation of the vessel or in-water activities and that affords the observers an optimal view of the sea surface. The PSOs will provide 360° coverage surrounding the work vessel and adjust their positions appropriately to ensure adequate coverage of the entire ZOI. The limits of the designated ZOI will be determined using binocular reticle or other equipment such as electronic rangefinder or range stick. Observations must be consistent, diligent, and free of distractions for the duration of the watch. PSOs will be on watch at all times during daylight hours when in-water operations are being conducted, unless conditions (e.g., fog, rain, and darkness) make sea surface observations impossible. If conditions deteriorate during daylight hours such that the sea surface observations are halted, visual observations must resume as soon as conditions permit.

If a protected species is observed, the PSO will note and monitor the position (including relative bearing and estimated distance to the animal) until the animal dives or moves out of visual range of the observer. The PSO will continue to observe for additional animals that may surface in the area; often, there are numerous animals that may surface at varying time intervals. Any time a protected species is observed within the designated ZOI, the PSO will call for the immediate shut-down of in-water operations. Each PSO will be provided with a two-way radio dedicated to marine animal watch-related communication between the PSO and field operations manager. Any shut-down of activities due to a protected species sighting within the ZOI must be maintained until the sighted animal(s) has exited the ZOI or (if the sighted animal[s] dive) for a period of 30-minutes.

Records will be maintained of all protected species sightings in the area, including date and time, weather conditions, species identification, approximate distance from the pile, direction and heading in relation to the pile driving, and behavioral observations. When animals are observed in the impact zone, additional information and corrective actions taken, such as a shutdown of the pile driver, duration of the shutdown, behavior of the animal, and time spent in the safety zone, will be recorded. The PSOs also will identify and record large schools of fish, marine mammals, mats of the floating alga *Sargassum,* jellyfish aggregations, or other indicators of a biologically productive area. During pile-driving activities, data regarding the types of piles driven (e.g., material construction, diameter and length of pile, and wall thickness), type and power of the hammer used, number of cold starts, strikes per minute, and duration of the pile-driving activities will be recorded.

In the unanticipated event of a take of a listed species, re-initiation of consultation with the National Marine Fisheries Service (NMFS) Protected Resources Division is required. If a take of a listed species occurs from pile driving activities, a report of the incident will be submitted by e-mail to NMFS' Protected Resources Division at takereport.nmfsser@noaa.gov. All other dead or injured protected species will be reported to the marine mammal stranding hotline (877-433-8299) or to the local stranding network contacts (http://www.sefsc.noaa.gov/seaturtleSTSSN.jsp and http://www.nmfs.noaa.gov/pr/health/networks.htm). All other dead or injured protected species incidents will be reported to NMFS' Southeast Regional Office by telephone at (727) 824-5312 or Fax at (727) 824 5309.

3.0 PROTECTED SPECIES MANAGEMENT AND MITIGATION MEASURES FOR OFFSHORE CONSTRUCTION ACTIVITIES

3.1 PILE-DRIVING ACTIVITIES

Anchors for the unloading buoys will be driven piles, which would occur over a period of approximately 2 weeks during construction activities. This section lists mitigation measures designed to lessen potential acoustic impacts and visual monitoring protocols for protected species.

3.1.1 Acoustic Disturbance Mitigation Measures

The following impact mitigation measures will be implemented to reduce potential acoustic impacts to protected species during pile-driving activities:

- Vessel crew and contractors would be requested to use equipment and procedures that minimize noise. The use of enclosures and mufflers on equipment would be a viable option as well as minimizing the use of thrusters. Sound-muffling devices or engine covers will be used where appropriate, and engines and equipment will be turned off when not in use.
- During pile-driving activities, the power of impact hammers will be reduced to minimum energy levels required to drive a pile, thus reducing the amount of noise produced in the marine environment.
- All vessel crew members and contractors would be requested to "ramp-up" (also known as "soft start" or "slow build up"), which entails the gradual increase in intensity of a sound source. Ramping up involves slowly increasing the power of the hammer and noise produced over the ramp-up period. In this case, "dry firing" of a pile-driving hammer is a method of raising and dropping the hammer with no compression of the pistons, producing a lower-intensity sound than the full power of the hammer. The intent of ramp-up is to either avoid or reduce the potential for instantaneous hearing damage (from the sudden initiation of an acoustic source at full power) to an animal that might be located in close proximity. The intent of gradually increasing the sound levels of a sound source is to warn animals of pending acoustic operations and to allow sufficient time for those animals to leave the immediate area.
- To minimize excessive noise, engines on all equipment and vessels will be maintained in accordance with manufacturer's recommendations.
- Pile driving may continue into nighttime hours only if ramp-up/dry firing protocols have been conducted during daylight hours. In the event of a shutdown at night, the air hammer cannot be restarted until daylight visual monitoring activities are resumed.

3.1.2 Visual Monitoring Procedures

During daylight hours, an 820-ft (250-m) ZOI will be established around a pile to be monitored (a 656-ft [200-m] radius to the 160-dB isopleths, plus an additional 164-ft [50-m] watch zone). The PSO will monitor the 820-ft [250-m] ZOI to prevent or minimize potential adverse impacts to protected species. The 820-ft [250-m] ZOI will be observed for protected species for at least 45 minutes prior to initiating all pile-driving activities (i.e., each time a hammer is started). Each time a pile driving hammer is started, dry firing or ramping up of the hammer will be conducted for at least 15 minutes to allow animals the opportunity to leave the area. The 45-minute observation period may occur during dry firing and ramping up of the pile-driving hammer (i.e., observations may begin 30 minutes prior to dry firing or ramp-up). Pile driving will be stopped if any protected species are sighted within the ZOI or a protected species is observed moving toward the ZOI. The on-site construction manager must comply immediately with such a call by an on-watch PSO. Any disagreement or discussion should occur only after shut-down. Pile driving will not restart until the animal is confirmed to be outside of the ZOI. If at any time a protected species is observed in the ZOI during dry firing or ramp-up, the hammer will be shut down until the animal has left the ZOI of its own volition; ramp-up procedures will then be repeated. Visual monitoring during nighttime activities will consist of monitoring the area illuminated by work lights. Ramp up will not occur during the night.

3.2 OTHER OFFSHORE CONSTRUCTION ACTIVITIES

Other offshore construction activities include siting the unloading buoys (STL buoys) and associated equipment and laying the marine pipeline. Visual mitigation monitoring methods for general offshore construction activities are presented in this section.

Daylight Operations

A 328-ft [100-m] ZOI will be established around the construction vessel to be monitored, which the PSO will monitor to prevent or minimize potential adverse impacts to protected species. Personnel associated with the project will undergo a briefing of the potential presence of protected species in the project area and harm avoidance and other mitigation requirements. All construction personnel will observe water-related activities for the presence of these species. If a protected species is seen within the ZOI, all appropriate precautions will be implemented to ensure its protection. These precautions will include cessation of operation of any moving equipment within 300 ft (91 m) of a protected species. Activities may not resume until the animal has departed the project area of its own volition.

Nighttime Operations

Construction activities may continue into nighttime hours. Visual monitoring will be limited to areas illuminated by the construction vessel(s). Ramp up will not occur during the night.

3.3 VESSEL STRIKE CONCERNS

Several construction and support vessels will be used during offshore construction activities. Consequently, there is the possibility for a vessel strike with protected species to occur within the project area. Port Dolphin will instruct all personnel associated with the project of the potential presence of protected species. All vessel crew members and contractors will participate in fisheries training for protected species presence and emergency procedures in the unlikely event a protected species is struck by a vessel. Construction and support vessels will follow the NMFS Vessel Strike Avoidance Measures and Reporting for Mariners. Standard measures will be implemented to reduce the risk associated with vessel strikes or disturbance of these protected species to discountable levels. The following sections present strike avoidance measures for manatees (**Section 3.3.1**), cetaceans (**Section 3.3.2**), and sea turtles (**Section 3.3.3**).

3.3.1 Manatee – Vessel Strike Avoidance Measures

The following manatee-vessel strike avoidance measures for active installation/decommissioning vessel operations will be implemented during project activities:

- If a manatee is within 50 ft (15 m) of a construction or support vessel underway, all operations will discontinue until it has left the vicinity of its own volition.
- If a manatee is within 300 ft (91 m) of an active construction or support vessel underway, it will be observed and the vessel will proceed with caution, following the guidelines below:
    - Resume vessel at slow speeds,

  - Stay on parallel course with manatee – follow behind or next to at an equal or lesser speed,
  - Do not cross path of manatee,
  - Do not attempt to steer or direct manatees away, and
  - Do not allow the vessel to come between a mother and her calf.
- Practical speeds will be maintained to the extent possible when applicable. Guidelines for speeds include the following:
  - No wake/idle speeds when the draft of the vessel is less than 4 ft (1.2 m) from seafloor. All vessels would follow routes of deep water whenever possible,
  - All construction vessels transiting to and from the port from shore would not exceed 14 knots during regular operations,
  - Avoid sudden changes in speed and direction,
  - Speeds approaching and departing the buoys would be reduced to 10 knots maximum,
  - Anchors for the unloading buoys will be driven piles, which would occur over a period of approximately 2 weeks during construction activities.
  - Speeds during installation would be well under 14 knots; vessel may be stationary during certain phases of installation, and
  - Higher speeds would only be used if safety reasons warrant.
- Members of the vessel crew would be encouraged to undergo NOAA Fisheries training for observing mammals. Topics covered in the training course may include reporting procedures, collision emergency procedures, and marine mammal presence detection.
- During installation and decommissioning, lookouts are required to scan for surfacing mammals and report any sightings to the Captain, who would notify the Environmental Coordinator.
- Offshore construction activities would be temporarily terminated if manatees were observed in the area and there is the potential for harm of an individual. The Environmental Coordinator would be called in to determine the appropriate course of action.
- During construction of the facility, an Environmental Coordinator would be on site and responsible for communicating with NOAA Fisheries Service and USFWS/FWC personnel, as appropriate.
- If a collision seems likely, emergency collision procedures will be followed.
- In the unlikely event a manatee is struck, the FWC Law Enforcement (1-888-404-FWCC or *FWC on a cellular phone) and the U.S. Fish and Wildlife Service in Tampa, Florida (813-348-1523) and/or the NOAA Fisheries Office for Law Enforcement Hotline (1-800-853-1964) would be notified.

3.3.2 Cetacean – Vessel Strike Mitigation Measures

The following cetacean-vessel strike mitigation measures for active installation/decommissioning vessel operations will be implemented during project activities:

- Construction or support vessel vessels, while underway, would remain 300 ft (91 m) away from all cetaceans to the extent possible.
- If a cetacean is within 50 ft (15 m) of a construction or support vessel underway, all operations will cease until it is >300 ft (91 m) from vessel. If the cetacean is within 300 ft (91 m) of an active construction or support vessel underway, it will be observed and the vessel will proceed with caution, following the guidelines below:
  - Resume vessel at slow speeds,
  - Stay on parallel course with the cetacean – follow behind or next to at an equal or lesser speed,
  - Do not cross the path of the cetacean,
  - Do not attempt to steer or direct the cetacean away,
  - If a cetacean exhibits evasive or defensive behavior, stop the vessel until the cetacean has left the immediate area, and
  - Do not allow the vessel to come between a mother and her calf.

- If a sighted cetacean is believed to be a North Atlantic right whale, Federal regulation requires a minimum distance of 1,500 ft (457 m) from the animal be maintained (50 CFR 224.103 (c)).
- Practical speeds will be maintained to the extent possible. Guidelines for speeds include the following:
  - No wake/idle speeds where the draft of the vessel provides less than a 4-ft (1.2-m) clearance from the bottom. All vessels would follow routes of deep water whenever possible,
  - All construction vessels transiting to and from the port from shore would not exceed 14 knots during regular operations as most collisions causing lethal or severe injuries involve vessels moving at 14 knots or faster,
  - Avoid sudden changes in speed and direction,
  - Speeds approaching and departing the buoys would be reduced to 10 knots maximum,
  - Speeds during installation would be well under 14 knots; vessel may be stationary during certain phases of installation, and
  - Higher speeds would only be used if safety reasons warrant.
- Members of the vessel crew would be encouraged to undergo NOAA Fisheries training prior to activity. Topics in the training course include reporting procedures, collision emergency procedures, and cetacean presence detection (surfacing near wake).
- During installation and decommissioning, lookouts are required to scan for surfacing cetaceans and report sightings to the Captain, who would notify the Environmental Coordinator.
- Offshore construction activities would be temporarily terminated if cetaceans were observed in the area and there is the potential for harm of an individual. The Environmental Coordinator would be called in to determine the appropriate course of action.
- During construction of the facility, an Environmental Coordinator would be on site and responsible for communicating with NOAA Fisheries Service and USFWS/FWC personnel, as appropriate.
- If a collision seems likely, emergency collision procedures will be followed.
- In the unlikely event a cetacean is struck, the FWC Law Enforcement (1-888-404-FWCC or *FWC on a cellular phone) and the USFWS in Tampa, Florida (813-348-1523) and/or the NOAA Fisheries Office for Law Enforcement Hotline (1-800-853-1964) will be notified.
- Injured, dead, or entangled right cetaceans should be immediately reported to the U.S. Coast Guard (USCG) via VHF Channel 16.

3.3.3 Sea Turtle – Vessel Strike Mitigation Measures

The following sea turtle-vessel strike mitigation measures for active installation/decommissioning vessel operations will be implemented during project activities:

- Practical speeds will be maintained to the extent possible. Guidelines for speeds include the following:
  - No wake/idle speeds where the draft of the vessel provides less than a 4-ft (1.2-m) clearance from the bottom. All vessels would follow routes of deep water whenever possible,
  - All construction vessels transiting to and from the port from shore would not exceed 14 knots during regular operations,
  - Avoid sudden changes in speed and direction,
  - Speeds approaching and departing the buoys would be reduced to 10 knots maximum,
  - Speeds during installation would be well under 14 knots; vessel may be stationary during certain phases of installation, and
  - Higher speeds if safety reasons warrant.
- All vessel crew members and contractors would participate in the NOAA Fisheries training for sea turtle presence and emergency procedures in the unlikely event a sea turtle is struck by a vessel.

- Lighting will be down-shielded to prevent unnecessary upward illumination while illuminating the vessel decks only. They would not illuminate surrounding waters. Lighting used during all activities will be regulated according to USCG requirements, without using excessive wattage or quality of lights. Once an activity is completed, all lights used only for that activity would be extinguished.
- During installation and decommissioning, lookouts are required to scan for surfacing turtles and report sightings to the Captain, who would notify the Environmental Coordinator.
- During construction of the facility, an Environmental Coordinator would be on site.
- In the unlikely event a sea turtle is struck, the vessel Captain or Environmental Coordinator will report to the NOAA Fisheries Southeast Regional Office (727-824-5312) and immediately notify the FWC Law Enforcement (1-888-404-FWCC or *FWC on a cellular phone).

3.4 LINE AND CABLE ENTANGLEMENT CONCERNS

The following BMPs will be implemented to prevent entanglement in any lines or cables or siltation barriers used in any construction area to avoid the potential for entanglement of protected species.

- Siltation barriers will not be made of any materials in which a protected species can become entangled (e.g., monofilament), will be properly secured, and will be regularly monitored to avoid protected species entrapment.
- Siltation barriers will not block protected species entry or exit points from habitat without prior agreement from NMFS' Protected Resources Division, St. Petersburg, Florida.
- Lines with mandated modifications, such as knotless and non-floating material, will be used on construction vessels.
- Any lines or other equipment that have the potential to become a source of entanglement for marine mammals will only be deployed as long as necessary to complete the task and would be removed from the site.
- Any lines or other equipment that have the potential to become a source of entanglement for marine mammals will be kept as taut as possible to prevent entanglement; however, a certain amount of slack is necessary to account for currents, tides, and other factors.
- In the unlikely event that entanglement appears likely, the operator would remove the source as quickly as possible or take in the slack.
- If temporary buoys need to be placed, materials such as heavy chains or cables will be used to avoid material that may enable entanglement.
- In the unlikely event a mammal becomes entangled, the FWC Law Enforcement (1-888-404-FWCC or *FWC on a cellular phone) or the Marine Mammal Hotline of NOAA Fisheries (1-888-256-9840) and the Disentanglement Hotline (800-900-3622) will be notified.

3.5 MARINE DEBRIS CONCERNS

The following BMPs will be implemented to prevent potential impacts to protected species from debris discarded within any construction area:

- Marine debris training consistent with MMS NTL 2007-G03 Marine Trash and Debris Awareness and Elimination (http://www.gomr.mms.gov/homepg/regulate/regs/ntls/?007NTLs/07-g03.pdf) will be provided to all personnel working on the project.
- All vessel crew members and contractors will be responsible for ensuring that no debris inadvertently enters the water, thus reducing the chances of entanglement and eliminating pollution to marine habitats.

- Discharge or disposal of garbage and other solid debris from vessels will be prohibited, consistent with MMS (30 CFR 250.300) and the USCG regulations. Discharge of plastics will be strictly prohibited and will never be authorized. This includes ashes from burned plastics. All plastics will be returned to shore and tracked. No food or garbage will be discharged, and all waste will be offloaded onshore for proper disposal.
- No wildlife will be fed or purposely attracted to the vessel, and fishing is not allowed.
- A Waste Management Plan will be developed and implemented as part of the port operations manual.

Appendix C

Assessment of Underwater Noise

PORT DOLPHIN ENERGY LLC DEEP WATER PORT: ASSESSMENT OF UNDERWATER NOISE

Version 2.0

By

Isabelle Gaboury
Roland Gaboury
Mikhail Zykov
Scott Carr

JASCO Research Ltd.

Suite 432 – 1496 Lower Water Street, Halifax, Nova Scotia B3J 1R9

Tel: +1.902.405.3336

Email: halifax@jasco.com

for

CSA International, Inc.

8502 SW Kansas Ave, Stuart, FL 34997

Tel: +1.772.219.3000

23 Jan 2008

Version	Date	Description	Approved by:
1.0	18 Jan. 2008	First release version	Isabelle Gaboury
2.0	23 Jan. 2008	Revised results for SRV transit and approach	Isabelle Gaboury

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1 Project Description

Port Dolphin Energy LLC proposes to construct and operate a Liquefied Natural Gas (LNG) Deepwater Port (DWP) at a site approximately 45 km (28 mi) west of Tampa Bay, Florida. The project will consist of two submerged turret unloading and mooring buoys, located in approximately 30 m (98 ft) of water, connected to Port Manatee in Tampa Bay via a pipeline approximately 68 km (42 mi) in length. The buoys will serve LNG Shuttle and Regasification Vessels (SRV's), purpose-built ocean going LNG vessels capable of regasifying the LNG onboard and delivering natural gas to the sub-sea pipeline.

Underwater noise will be generated during both the construction and operational phases of the deepwater port. During construction, noise will be generated from construction vessels, pile driving, and plowing of the pipeline, and to a lesser extent from drilling and dredging operations. During operation of the port, underwater noise will be generated by the operation of the SRV's during transit and docking/undocking and by acoustic transponders on the unloading buoys. Both types of noise will be intermittent.

This report details the results of acoustical modeling carried out by JASCO Research, Ltd., in order to predict the sound fields likely to be generated by construction and operation activities associated with the Port Dolphin DWP project. The scenarios modeled, including the layout of equipment and source levels associated with various vessels and activities, are outlined in Section 2. Natural sources of ambient noise that are likely to occur within the study area are also discussed. Model methodology and environmental parameterization are discussed in Sections 3 and 4, respectively. Finally, the results of the modeling study are presented in Section 5.

2 Modeling Scenarios and Source Level Characterization

Levels of underwater sound were modeled using JASCO's Marine Operations Noise Model (described in Section 3) for a variety of locations and activities, representing different stages of construction and operation of the Port Dolphin facility. The sites, equipment, and levels of underwater noise associated with these scenarios are discussed in the following sub-sections. Third-octave band source levels are also tabulated in Appendix A.

2.1 Study Area

The region around the Port Dolphin DWP, inshore of the 50 m (164 ft) isobath, is shown in Figure 1. As discussed in the following section, modeling was carried out for activities occurring at a number of locations in the vicinity of the DWP, including along the SRV transit route, at the buoys, and along various portions of the pipeline connecting the unloading buoys to Port Manatee (Figure 1).

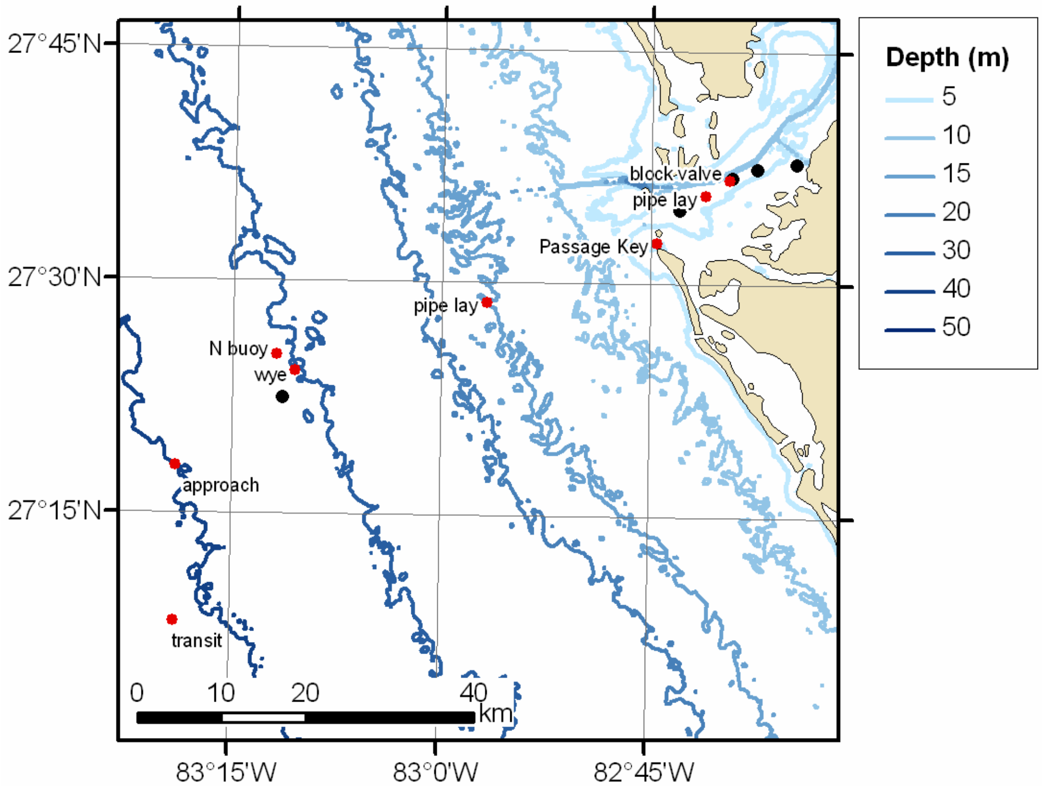

Figure 1: Overview of modeling sites. Dots mark key points along the carrier route and pipeline. The pipeline extends from the two buoys at the western-most end to the Port Manatee shore approach at the eastern-most end. Red dots represent model sites.

2.2 Model Scenarios and Source Levels

The scenarios that were modeled as part of this study are outlined in Table 1. Activities and locations were selected to represent key elements of the construction and operation of the DWP. The equipment list associated with each activity is based on current construction plans (Ocean Specialists, 2007). For each piece of equipment specified, proxy vessels were selected from JASCO Research's database of underwater noise measurements (right-most column of Table 1); this is discussed further in the following sub-sections.

Note that in many cases the scenarios involve multiple pieces of equipment. Although equipment spacing will vary during the course of operations, a single layout must be assumed for modeling purposes. As such, where multiple vessels were involved in the scenarios listed in Table 1 the following layout was assumed:

- The barge used for the main operation in each scenario (crane vessel, pipe laying barge, pipe burial barge) was set in the middle of the group of vessels.
- For four or fewer tugs (anchor handling and/or support), tugs were spaced at a range of 100 m (328 ft) from the center of the barge. Note that the pipe laying/burial barge itself is 122 m long by 30 m wide (400 ft x 100 ft).
- For pipe laying at Passage Key, the fifth standby tug was placed at a range of 200 m (656 ft) from the barge.

Table 1: Summary of model scenarios for the Port Dolphin LNG project. See also Figure 1. Proxy vessels and activities are discussed further in the sub-sections that follow.

Scenario		Location	Specified equipment	Proxy vessel/activity (for source levels)
Construction scenarios				
1	Installation of anchors, buoys, and anchor chains	North buoy	Crane vessel	Castoro II (barge), anchor operations
			Cargo barge	Assumed to be passive, hence negligible contribution
			Support vessel	Britoil 51 (tug), transiting
2	Impact pile driving (offshore)	Piggable wye site	Impact hammer	Menck MHU 3000
3	Impact pile driving (inshore)	Subsea block valve site	As for pile driving offshore	
4	Pipe laying (offshore)	15m isobath	Barge	Castoro II (barge), pipe laying
			2 anchor handling tugs	Britoil 51 (tug), anchor operations
			Support tug	Britoil 51 (tug), transiting
5	Pipe laying (inshore)	Tampa Bay	As for pipe laying offshore	

Scenario		Location	Specified equipment	Proxy vessel/activity (for source levels)
6	Pipe laying through Passage Key—live boat method	Passage Key	Barge	Castoro II (barge), pipe laying
			2 anchor handling tugs	Britoil 51 (tug), anchor operations
			2 live maneuvering tugs	Britoil 51 (tug), transiting
			Live tug on standby	Britoil 51 (tug), transiting
7	Pipeline burial—plowing (offshore)	15m isobath	Plow system	Aquarius dredge
			2 anchor handling tugs	Britoil 51 (tug), anchor operations
8	Pipeline burial—plowing (inshore)	Tampa Bay	As for pipe burial offshore	
Operational scenarios				
9	Offshore transit	34 km (18 nm) southwest of the unloading buoy	SRV, 36.1 km/h (19.5 kn) (90% propulsion)	Modeled SRV, full speed transit
10	Buoy approach	18 km (10 nm) southwest of the unloading buoy	SRV, <18.5 km/h (<10 kn) (half ahead)	Modeled SRV, half speed transit
11	Docking	Mooring buoy	SRV, dead slow, + bow and stern thrusters	Modeled SRV: main propulsion at dead slow, 2 bow thrusters and 1 stern thruster

2.2.1 Installation of anchors, buoys, and anchor chains

Proxies were selected for the crane and support vessels based on vessel specifications (Figure 2(a,d)). While a cargo barge may be present on-site for a portion of the operations, it was assumed that this barge would typically not be under power.

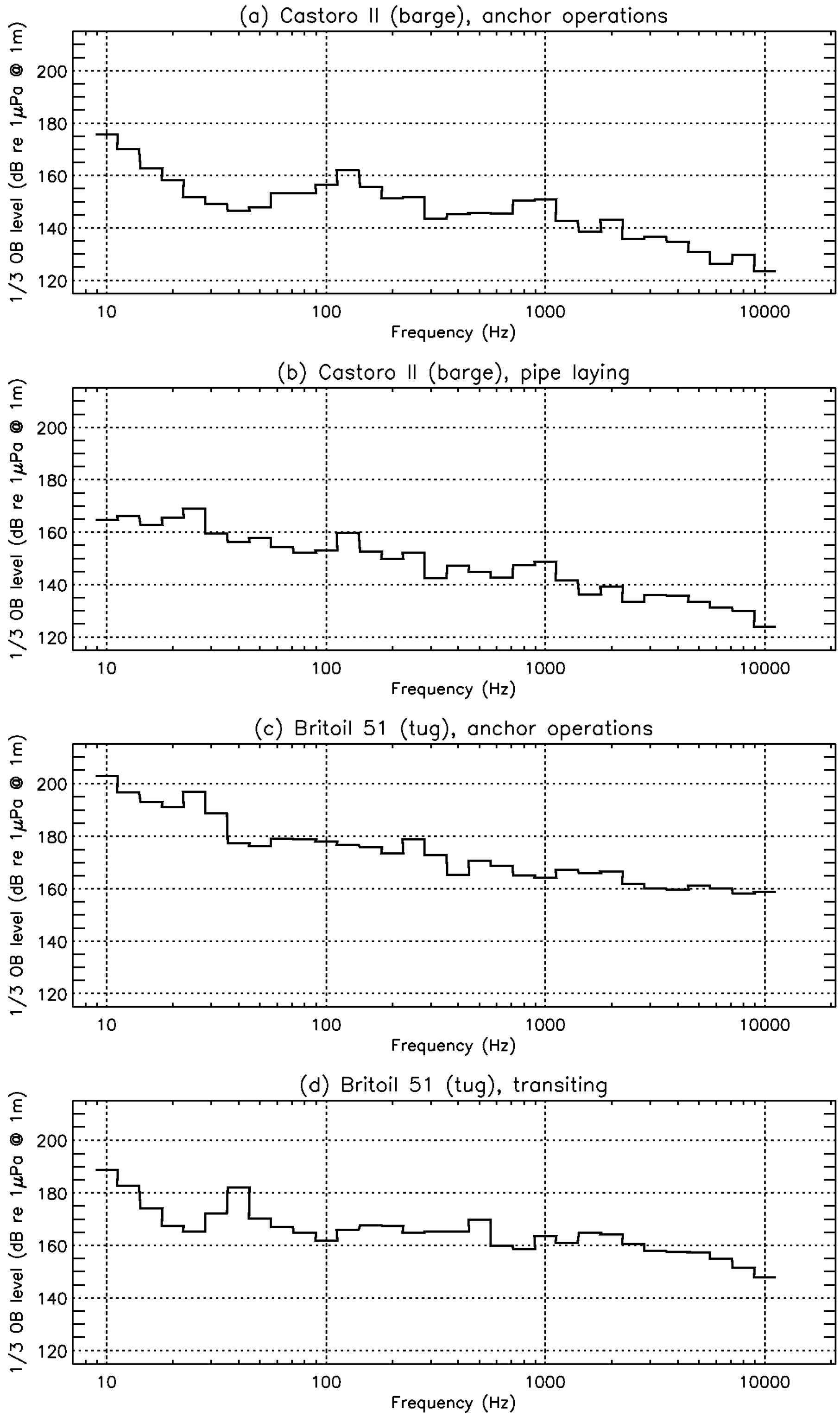

Figure 2: Third-octave band source levels for vessels involved in construction-related modeling scenarios (see Table 1). Source depths are 2.2 m and 3 m for the Castoro II and Britoil 51, respectively. Broad-band source levels are (a) 177 dB re μPa, (b) 174 dB re μPa, (c) 205 dB re μPa, and (d) 191 dB re μPa.

2.2.2 Impact Pile Driving

Piles may be driven as part of pipeline initiation at the piggable wye and subsea block valve sites (Figure 1, Table 1). The impact hammer involved is expected to be the same as that used for the Neptune LNG project (LGL and JASCO, 2005). As such, the same source levels were used (Figure 3(a)). For both the offshore and inshore scenarios, the source depth for pile driving was set to approximately half the local water depth (Figure 2(a)). In actuality, sound will radiate from all portions of the pilings; this mid-water column value is a precautionary estimate of the depth for an equivalent point source, as losses due to bottom and surface interactions will be less for a source at mid-depth than for one near the sea floor or surface.

Impact hammering operations will involve a pipe lay barge and tugs, similarly to pipe laying (Table 1). However, because the potential impact to marine mammals and turtles is different for impulsive and continuous sources, impact hammering noise (an impulsive source) is considered separately from vessel noise (continuous sources). Note that the source levels from impact hammering are much higher than those from the vessels that are likely to be on-site (Figure 2, Figure 3(a)).

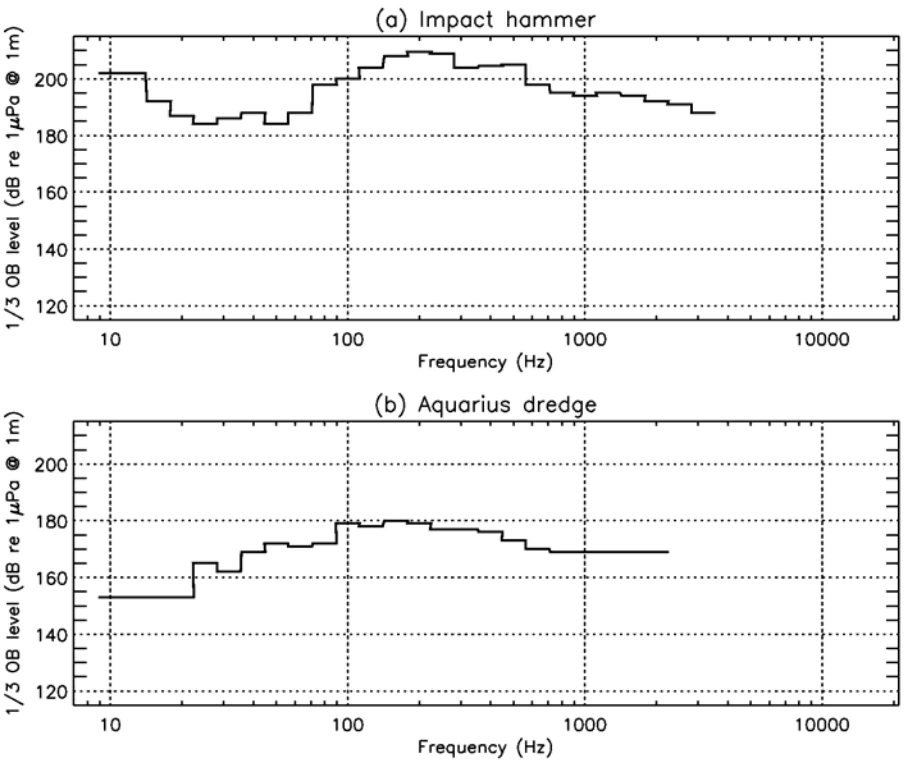

Figure 3: Third-octave band source levels for non-vessel activities involved in construction-related modeling scenarios (see Table 1). Source depth for the impact hammer is half the local water depth; source depth for the dredge is 2.2 m. Broad-band source levels are (a) 216 dB re μPa (assuming a 10 dB SEL-to-RMS offset) and (b) 188 dB re μPa.

2.2.3 Pipe Laying

A total of three sites were selected for pipe laying: one approximately mid-way along the offshore portion of the pipeline, another along the inshore portion, and a third at Passage Key (Figure 1, Table 1). Equipment lists for the offshore and inshore sites are identical: a pipe laying barge, two tugs involved in re-setting of anchors, and a third tug in transit (Table 1, Figure 2(b,c,d)). At Passage Key Inlet, shallow water and tidal currents are expected to require a modification of the pipe laying approach. The noisiest of the alternatives, referred to as the “live boat” method (Ocean Specialists, 2007), would require two additional tugs for live handling compared with the equipment setup used for most of the pipeline route (Table 1).

2.2.4 Pipe Burial

Similarly to pipe laying, pipe burial using a trenching plow system will consist of an anchored barge accompanied by two anchor handling tugs. In addition, noise will be generated by the plow used to bury the pipe line (Table 1). Detailed source level data were not available for plow operations. However, Aspen Environmental Group (2005) reported a broadband source level of 185 dB re 1 μPa at 1 m. Based on this information, source levels from the cutter-suction dredger Aquarius (Greene, 1987) were used for modeling purposes (Figure 3(b)). Note that the dredge source levels include the sound from the barge upon which the dredge is operated; consequently, a separate barge is not specified for plowing operations in Table 1. However, based on the observation from clamshell dredging that the highest levels of underwater sound are emitted from equipment on the barge rather than from the scraping sounds of the dredge itself (Richardson *et al.*, 1995), the source depth for plowing was taken to be that of the pipe laying/burial barge.

2.2.5 Operational Scenarios: SRV Transit and Docking

Operational procedures for the SRV's specify maximum allowable transit speeds during transit to the unloading buoys, as well as probable use of thrusters during approach and docking (Table 2). During offshore transit (i.e., over 34 km / 18 nm from the unloading buoys), SRV's travel at full service speed, which in calm weather can be up to 36.1 km/h (19.5 kn). Speed is gradually reduced as the SRV approaches the unloading buoys, until main propulsion is at dead slow (Table 2). Bow and stern thrusters are used during docking. Once moored, ship's propulsion is not required for positioning.

Based on these operational procedures, three sample situations were selected for modeling (see Table 1):

- Offshore transit at full service speed
- Approach at half speed to 10 nm distance from the unloading buoy
- Docking at the northern buoy, using both bow thrusters and one stern thruster

Table 2: Speed limits and thruster operation during approach of SRV's to the unloading buoys and subsequent docking. Point A is located 5.6 km (3 nm) from the unloading buoys.

Zone	Speed limit	Thrusters?
>28 km (15 nm) off point A	Full service speed (36 km/h, 19.5 kn)	No
20-28 km (11-15 nm) off point A	Full maneuver speed (<26 km/h, <14 kn)	No
11-20 km (6-11 nm) off point A	Half ahead (<19 km/h, <10 kn)	No
0-11 km (0-6 nm) off point A	Slow ahead (<11 km/h, <6 kn)	No
Point A to safety zone	Dead slow ahead (<8.3 km/h, <4.5 kn)	Bow and stern thrusters in operation
Inside safety zone	Dead slow ahead (<5.6 km/h, <3 kn)	Bow and stern thrusters in operation
Docking	Dead slow	2 bow thrusters and possibly 1-2 stern thrusters in operation

Very little information is available on the underwater noise levels radiated by LNG carriers. However, some data and empirical formulas have been developed for large tankers in general. At typical cruising speeds, source levels from such vessels are dominated by propeller cavitation (Sponagle, 1988; Seol *et al.*, 2002). As described by LGL and JASCO (2005), an empirical expression for the source spectrum level (1 Hz bandwidth) in the frequency range between 100 Hz and 10 kHz is

$$SL = 163 + 10\log BD^4 N^3 f^{-2} \text{ dB re 1 µPa}$$

Here *B* is the number of blades, *D* is the propeller diameter in meters, *N* is the number of propeller revolutions per second, and *f* is the frequency in Hz. For frequencies less than 100 Hz, the source level is assumed to be constant at the 100 Hz level. In the case of ducted propellers (e.g., bow and stern thrusters), the constant is approximately 7 dB larger. The parameters used for modeling of a "typical" SRV are listed in Table 3. Specifications for the main propulsion system are based on a typical carrier, and are similar to those described by LGL and JASCO (2005). Bow and stern thrusters are expected to be single-speed, controllable-pitch devices, with power ratings of 2,000 kW each for the bow thrusters and 1,200 kW each for the stern thrusters. Based on these values, diameters and rates of revolution for the thrusters (Table 3) were based on specifications for the most common models currently available. Note that only a single set of parameters is shown for the thrusters, as rates of revolution do not change with power output for single-speed thrusters. The above model is not able to take into account the reduction in source levels that would result from a change in pitch at lower power outputs; hence, the modeled source levels are conservative (i.e., represent maximum expected levels of underwater noise).

The resulting estimated source levels for the SRV are shown in Figure 4.

Table 3: Parameters used to model cavitation noise from SRV main propulsion and thrusters.

Description	**Number of blades (*B*)**	**Diameter (*D*)**	**Propeller revolutions per minute**	**Propeller revolutions per second (*N*)**
Main propulsion, full speed	4	8.5	87	1.45
Main propulsion, half speed	4	8.5	45	0.75
Main propulsion, dead slow	4	8.5	10	0.17
Bow thruster	4	2.4	200	3.33
Stern thruster	4	2.0	245	4.08

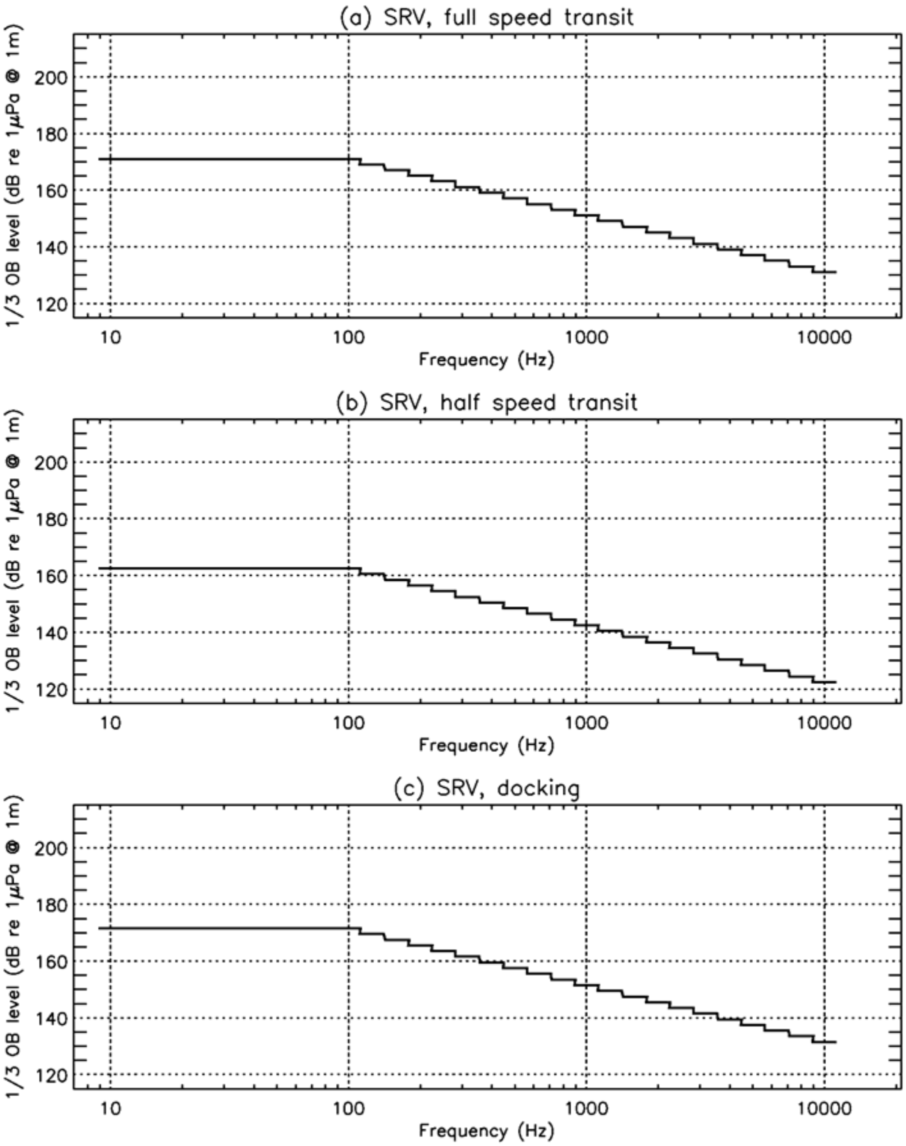

Figure 4: Third-octave band source levels for operational modeling scenarios (see Table 1). Source levels for docking (c) include main SRV propulsion at dead slow, two bow thrusters at half-power, and one stern thruster at half-power. Source depth is 6 m in all cases. Broad-band source levels are (a) 182 dB re μPa, (b) 174 dB re μPa, and (c) 183 dB re μPa.

2.3 Additional Sources of Noise

The following additional sources of underwater noise are expected to be present during construction of the Port Dolphin DWP, but were not modeled:

- Dredging: Dredging will be involved in a few stages of construction, including horizontal directional drilling (discussed below) and pipe laying at the Sunshine Bridge crossing (Ocean Specialists, 2007). This will involve a clamshell or bucket-style dredge, operated from a barge while one or more additional barges carry out other tasks nearby. Measurements taken by JASCO during operation of a clamshell dredge indicated source levels of approximately 150-155 dB re 1 uPa, i.e. roughly 20 dB lower than the source levels associated with the

Castoro II during pipe laying operations (Figure 2). As such, dredging may be considered an insignificant source of noise compared with operation of the barges that will also be present.

- Horizontal Directional Drilling (HDD): HDD will be employed for installation of the pipe line at a number of locations along the inshore portion of the route, including the Port Manatee shore approach and two crossings of the Gulfstream pipeline (Ocean Specialists, 2007). This will involve using progressively larger drill strings to eventually produce a drill bore 1.22 m (48") in diameter. Simultaneously, bucket dredging will be employed to produce an exit hole at the end of the bore. Very little information exists regarding source levels from horizontal directional drilling. However, measurements taken of drillships (Greene, 1987) suggest that the contribution to the underwater noise field from drilling is likely to be far less than that from the barges from which drilling and/or dredging will be taking place.

Once the port is operational, an additional source of underwater sound in the vicinity of the unloading buoys will be the acoustic transponders installed on the buoys. Information was not available on the specific transponders intended for use at the Port Dolphin DWP at the time of writing of this report. However, specifications from commercially available buoy positioning transponders indicate operating frequencies of a few tens of kHz, and source levels of approximately 190 dB re 1 μPa at 1 m. Given this estimated broadband source level, we may estimate ranges to various threshold values assuming simple spherical spreading, i.e.

$$RL = SL - 20\log_{10}(r)$$

Solving for r, we find that received levels will drop to 180 dB at a range of approximately 3 m, and to 160 dB at a range of approximately 32 m. As such, only marine mammals passing very near the unloading buoys would potentially be affected. It should also be noted that this will be a highly intermittent source of underwater noise, as the transponders will only transmit when interrogated by the SRV-based command unit.

2.4 Ambient Noise

Even in the absence of man-made sounds, the sea is typically a noisy environment. A number of natural sources of noise are likely to occur within Tampa Bay and the adjoining shelf, including the following (see Chapter 5 of Richardson *et al.* 1995):

- Wind and waves: The complex interactions between wind and water surface, including processes such as breaking waves and wave-induced bubble oscillations and cavitation, are a main source of naturally occurring ambient noise for frequencies between 200 Hz and 50 kHz (Mitson, 1995; Richardson *et al.*, 1995). In general, ambient noise levels tend to increase with increasing wind speed and wave height. Surf noise becomes important near shore, with measurements collected at a distance of 8.5 km (5.3 mi) from shore showing an increase of 10 dB in the 100 to 700 Hz band during heavy surf conditions (Richardson *et al.*, 1995).

- Precipitation noise: Noise from rain and hail impacting the water surface can become an important component of total noise at frequencies above 500 Hz, and possibly down to 100 Hz during quiet times (Richardson *et al.*, 1995).

- Biological noise: Marine mammals are the main contributors within this category, and can contribute significantly to ambient noise levels. In addition, some fish and shrimp may also make significant contributions (Richardson *et al.*, 1995). The frequency band for biological contributions is from approximately 12 Hz to over 100 kHz.

- Tidally generated noise: Where strong tidal currents occur, these flows may contribute to the ambient noise field via creation of turbulence, generation of surface waves, and transport of sediments along the sea floor (Thorne, 1990; Blackwell and Greene, 2002). The latter mechanism is particularly important where rapid tidal flows occur over loose, relatively large sediments such as gravel (e.g., Blackwell and Greene, 2002), and levels on the order of 70 dB in the 10 kHz region have been reported from measurements immediately above the sea bed (Thorne, 1990).

Sources of ambient noise related to human activity include transportation (surface vessels and aircraft), dredging and construction, oil and gas drilling and production, seismic surveys, sonars, explosions, and ocean acoustic studies (Richardson *et al.*, 1995). Shipping noise typically dominates the total ambient noise for frequencies between 20 and 300 Hz.

The sum of the various natural and anthropogenic noise sources at any given location and time depends not only on the source levels (as determined by current weather conditions and levels of biological and shipping activity) but also on the ability of sound to propagate through the environment. In turn, sound propagation is dependent on the spatially and temporally varying properties of the water column and sea floor (discussed further in Section 4), and is frequency-dependent. As a result of the dependence on a large number of varying factors, the ambient noise levels at a given frequency and location can vary by 10-20 dB from day to day (Richardson *et al.*, 1995).

Very few measurements of ambient noise from Tampa Bay and the adjoining shelf are available. Shooter *et al.* (1982) analyzed approximately 12 hours of data collected in deep (3280 m bottom depth) waters in the western Gulf of Mexico, and reported median ambient noise levels of 77-80 dB re. $\mu Pa^2/Hz$. These levels are likely to be somewhat lower than those occurring in the vicinity of Tampa Bay, due in large part to the reduced contribution from surf in deep water. Phillips *et al.* (2006) present measurements from manatee habitats in boating channels and rivers along the Florida coast, consisting of fairly flat or slightly sloping sea floors shallower than 5 m. Ambient noise measurements in these habitats range from 69 dB in Crystal River (away from the mouth of the river) to 105 dB near the mouths of the Crystal and Indian Rivers.

3 Modeling Methodology

Starting from source locations and levels for a given scenario (Section 2), the acoustic field at any range from the source(s) is estimated using an acoustic propagation model. Sound propagation modeling uses acoustic parameters appropriate for the specific geographic region of interest, including the expected water column sound speed profile, the bathymetry, and the bottom geoacoustic properties (see Section 4), to produce site specific estimates of the radiated noise field as a function of range and depth.

JASCO's Marine Operations Noise Model (MONM) is used to predict the directional transmission loss footprint from one or more source locations. MONM is an advanced modeling package whose algorithmic engine is a modified version of the widely-used the Range Dependent Acoustic Model (RAM) (Collins *et al.*, 1996). RAM is based on the parabolic equation method using the split-step Padé algorithm to efficiently solve range dependent acoustic problems. RAM assumes that outgoing energy dominates over scattered energy and computes the solution for the outgoing wave equation. An uncoupled azimuthal approximation is used to provide 2-D transmission loss values in range and depth. RAM has been enhanced by JASCO to approximately model shear wave conversion at the sea floor using the equivalent fluid complex density approach of Zhang and Tindle (1995).

Because the modeling takes place over radial planes in range and depth, volume coverage is achieved by creating a fan of radials that is sufficiently dense to provide the desired tangential resolution. This n × 2-D approach is modified in MONM to achieve greater computational efficiency by not over-sampling the region close to the source. The desired coverage is obtained through a process of tessellation, whereby the initial fan of radials has a fairly wide angular spacing (e.g., 5 degrees), but the arc length between adjacent radials is not allowed to increase beyond a preset limit (e.g., 1.5 km) before a new radial modeling segment is started, bisecting the existing ones. The new radial need not extend back to the source because its starting acoustic field at the bisection radius is "seeded" from the corresponding range step of its neighboring traverse.

The tessellation algorithm also allows the truncation of radials along the edges of a bounding quadrangle of arbitrary shape, further contributing to computational efficiency by enabling the modeling region to be more closely tailored to an area of relevance. MONM has the capability of modeling sound propagation from multiple directional sources at different locations and merging their acoustic fields into an overall received level at any given location and depth. The received sound levels at any location within the region of interest are computed from the ⅓-octave band source levels (see Section 2.2) by subtracting the numerically modeled transmission loss at each ⅓-octave band center frequency, and summing incoherently across all frequencies to obtain a broadband value.

3.1 Estimating 90% RMS SPL from SEL

For continuous noise sources (e.g., vessel noise), MONM predicts RMS sound pressure levels (SPL) upon which U.S. safety radius requirements are based. For impulsive noise sources (impact hammering) MONM predicts sound exposure level (SEL) over a nominal time window of 1 second. For *in situ* measurements of impulsive sound sources, SPL is related to SEL via a simple relation that depends only on the RMS integration period *T*:

$$SPL_{RMS90} = SEL - 10\log_{10}(T) - 0.458$$

Here the last term accounts for the fact that only 90% of the acoustic pulse energy is delivered over the standard integration period (Malme *et al.*, 1986; Greene, 1997; McCauley *et al.*, 1998). The pulse duration at any given point in the sound field is highly sensitive to the specific multi-path arrival pattern from an acoustic source. In the absence of *in situ* measurements, accurate direct forecasting of the pulse duration at any significant range from the source is computationally prohibitive at present. The best alternative is to use a heuristic value of *T*, based on field measurements in similar environments, to estimate an RMS level from the modeled SEL. Safety radii estimated in this way are approximate since the true time spreading of the pulse has not actually been modeled. For this study, the integration period *T* has been assumed equal to a pulse width of 0.1 s, resulting in the following approximate relationship between RMS SPL and SEL:

$$SPL_{RMS90} = SEL + 10$$

In various studies where the SPL_{RMS90}, SEL, and duration have been determined for individual airgun pulses, the average offset between SPL and SEL has been found to be 5 to 15 dB, with considerable variation dependent on water depth and geo-acoustic environment (Austin *et al.* 2003; MacGillivray *et al.* 2007).

3.2 Weighting for Hearing Capabilities of Marine Mammals and Turtles

In order to take into account the differential hearing capabilities of various groups of marine mammals, the M-weighting frequency weighting approach described by Miller *et al.* (2005) is commonly applied. The M-weighting filtering process is similar to the C-weighting method that is used for assessing impacts of loud impulsive sounds on humans. It accounts for sound frequencies extending above and below the most sensitive hearing range of marine mammals within each of five functional groups: low frequency cetaceans, mid-frequency cetaceans, high frequency cetaceans, pinnipeds in water and pinnipeds in air (Table 4). The filter weights Mw_i, for frequency band *i* with center frequency f_i, are defined by:

$$Mw_i = -20\log_{10}\left(\frac{f_i^2 f_{hi}^2}{\left(f_i^2 + f_{lo}^2\right)\left(f_i^2 + f_{hi}^2\right)}\right)$$

Here f_{lo} and f_{hi} are as listed in Table 4.

Table 4: Functional hearing groups and associated auditory bandwidths, as per Miller *et al.* (2005). Note that only the in-water bandwidth is shown for pinnipeds.

Functional hearing group	Members	Estimated auditory bandwidth (Hz)	
		f_{lo}	f_{hi}
Low-frequency cetaceans	Mysticetes	7 Hz	22 kHz
Mid-frequency cetaceans	Lower-frequency odontocetes	150 Hz	160 kHz
High-frequency cetaceans	Higher-frequency odontocetes	200 Hz	180 kHz
Pinnipeds	Pinnipeds	75 Hz	75 kHz

Three types of marine mammals have been identified as being of particular interest with respect to the proposed DWP, based on their frequency of occurrence and/or endangered status (Table 5). Bottlenose and Atlantic spotted dolphins are not endangered or threatened, but are common in the vicinity of the terminal; sperm whales and manatees are both endangered. The two dolphin species and sperm whales fall into Miller *et al.*'s (2005) mid-frequency cetacean grouping. The Florida manatee is not specifically referred to by Miller *et al.* (2005). However, measurements on captive manatees (Gerstein *et al.*, 1999; Gerstein, 2002) indicate a functional hearing range of 400 Hz to 46 kHz, within the bounds listed for pinnipeds (Table 4). As such, M-weightings for pinnipeds are used as a precautionary approximation for manatees in Section 5.

Although very little information exists on the hearing capabilities of sea turtles, available literature (primarily from loggerhead turtles) indicates that sea turtles hear low frequencies, with an effective hearing range of approximately 250 Hz – 750 Hz (Ridgway *et al.*, 1969; Moein, 1994; Bartol *et al.*, 1999). Given the limited data available, it is difficult to define specific upper and lower bounds as for marine mammal M-weightings. For the purposes of this project, low-frequency cetacean weightings were applied for turtles to provide some discounting of very high frequencies. However, this should be considered an extremely precautionary measure for sea turtles, whose effective hearing range appears to be much more limited than that of even low-frequency cetaceans.

Table 5: Key species of interest in the vicinity of the proposed Port Dolphin DWP and associated M-weightings (see Table 4). Note that the weightings applied for the Florida manatee and for sea turtles should be taken as precautionary approximations (see the text).

Species of interest	**Region**	**M-weighting**
Sperm whale	Offshore (shelf edge and continental slope)	Mid-frequency cetaceans
Dolphins: Bottlenose and Atlantic spotted	Coastal, shelf, and slope/deep	Mid-frequency cetaceans
Florida manatee	Coastal (Tampa Bay)	Pinnipeds
Sea turtles	Coastal, shelf, and slope	Low-frequency cetaceans

4 MONM Parameters

4.1 Source and Receiver Locations

Modeled source locations are shown in Table 6 below; see also Figure 1 in Section 2.1. These represent the center-points of the model field. Equipment was distributed around these center points as discussed in Section 2.2, with appropriate source depths based on the proxy vessels selected (see Figure 2 through Figure 4).

From each of the source location(s), the model generates a grid of acoustic levels over any desired area and for specified receiver depths. The following receiver depths were used in each case: 2 m intervals from surface to 10 m depth, then 5 m intervals to 20 m, then 10 m intervals to 100 m depth.

Table 6: Summary of modeling locations. See also Figure 1 in Section 2.1 and details of equipment layouts in Section 2.2.

Scenario		Location	Latitude (°N)	Longitude (°W)
Construction scenarios				
1	Installation of anchors, buoys, and anchor chains	North buoy	27° 25'12.14"	83° 11' 50.11"
2	Impact pile driving (offshore)	Piggable wye site	27° 24' 13.06"	83° 10' 27.72"
3	Impact pile driving (inshore)	Subsea block valve site	27° 36' 45.87"	82° 39' 17.98"
4	Pipe laying (offshore)	15m isobath	27° 28' 43.32"	82° 56' 41.64"
5	Pipe laying (inshore)	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
6	Pipe laying through Passage Key—live boat method	Passage Key	27° 32' 39.18"	82° 44' 30.95"
7	Pipeline burial—plowing (offshore)	15m isobath	27° 28' 43.32"	82° 56' 41.64"
8	Pipeline burial—plowing (inshore)	Tampa Bay	27° 35' 42.70"	82° 41' 0.97"
Operational scenarios				
9	Offshore transit	37 km (20 nm) west of the unloading buoy	27° 08' 00"	83° 19' 00"
10	Buoy approach	18.5 km (10 nm) west of the unloading buoy	27° 18' 00"	83° 19' 00"
11	Docking	North buoy	27° 25'12.14"	83° 11' 50.11"

4.2 Frequency Range

As discussed in Section 3, MONM computes transmission loss, and hence received sound levels, for individual third-octave bands. As there is a trade-off between the number of frequencies computed and computation time, it is desirable to use the minimum frequency range that will capture most of the energy from the sources present and provide good overlap with the hearing capabilities of the species of interest in the region.

For this study, a frequency range of 10 Hz to 2 kHz was used. While this upper limit is less than the upper limit of cetacean hearing (Section 3.2), the frequency characteristics of the sound sources involved in construction and terminal operations (Section 2.2) are such that this frequency range captures almost all of the sound energy emitted by the vessels and equipment, even when applying the relatively high-frequency cutoffs associated with M-weighting for mid-frequency cetaceans.

4.3 Bathymetry

The relief of the sea floor is one of the most crucial parameters affecting the propagation of underwater sound, and detailed bathymetric data are therefore essential to accurate modeling. For each of the sites, bathymetric data were extracted from the NGDC US Coastal Relief model (Divins and Metzger 2007) with a horizontal resolution of 3 arc-seconds (approximately 92 m in the N-S direction and 82 m in the E-S direction for the study area). Bathymetric contours are shown in Figure 1 of Section 2.1.

4.4 Geoacoustic Properties

Tampa Bay is located on the southwestern flank of the Ocala Platform (Brooks and Doyle, 1998). This section of consolidated sediments, which is represented by limestones of different formations, is covered by a thin layer of unconsolidated sediments. The top of the bedrock section consists of soft Miocene-Oligocene limestones with a thickness of 80-190 m, which is underlain by hard dolomite and limestone (Crandall, 2007).

Surface sediments in the region are dominated by the Tampa Bay ebb-tidal delta, which is responsible for continuous late-Holocene sediment cover extending to approximately 15 km offshore (Locker *et al.*, 1999; Hine *et al.*, 2001). These sediments consist of fine quartz sand, as well as some coarse sand and gravel size carbonates. While the sediment layer is variable, sediment thicknesses of 4-5 m are common near shore. Beyond the near-shore region, the sediment cover thins to expose occasional hard-bottom (Locker *et al.*, 1999). Similarly, sediments between the mouth of Tampa Bay and Port Manatee are primarily sandy (USGS, 2007). Sediment thicknesses here are typically less than 6 m, although this increases to a depth of 16-17 m within the deepest depressions (Brooks and Doyle, 1998; Edgar, 2002).

Taking into account the information presented above, the geoacoustic profile was constructed based on values suggested by Hamilton (1980), assuming an average profile consisting of 5 m of fine sand overlying two limestone layers (Table 7).

Table 7: Tampa Bay geoacoustic profile

Depth (m)	Description	Density (g/cm^3)	P-wave		S-wave	
			Velocity (m/s)	Attenuation	Velocity (m/s)	Attenuation
0–5	unconsolidated sandy sediment	1.8-1.85	1700–1750	0.8	200	0.1
5–125	soft limestone	2.5	2500	0.25		
>125	hard limestone	2.7	3500	0.13		

4.4.1 Alternative Profiles for Sensitivity Testing

Particularly in shallow water, where opportunities exist for multiple bottom interactions, model predictions are very sensitive to the bottom parameters used. As a result, uncertainty in the geoacoustic profile translates to uncertainty in the model results. For example, in the case of Tampa Bay and the adjoining continental shelf, there is considerable spatial variability in the thickness of the near-surface sand layer. In addition, there is some uncertainty in the thicknesses and geoacoustic properties of the underlying limestone layers.

In order to quantify these sources of variability, additional model runs were carried out with a series of modified geoacoustic profiles, based on the main profile in Table 7. The following variations were considered:

- The thickness of the sand layer was varied, from no sand at all to a maximum thickness of 10 m.
- The properties of the soft limestone layer were modified to simulate a slightly harder, higher-velocity rock: density was increased by 0.1 g/cm^3, and p-wave velocity was increased by 500 m/s.
- The depth of the interface between the soft and hard limestones was varied from 80 m to 190 m, bracketing the range of interface depths reported by Crandall (2007).

4.5 Sound Speed Profiles

Sound speed profiles in the ocean for each modeling location were derived from the US Naval Oceanographic Office's Generalized Digital Environmental Model (GDEM) database (Teague *et al.*, 1990). The latest release of the GDEM database (version 3.0) provides average monthly profiles of temperature and salinity for the world's oceans on a latitude/longitude grid with 0.25 degree resolution. Profiles in GDEM are provided at 78 fixed depth points up to a maximum depth of 6,800 m. The profiles in GDEM are based on historical observations of global temperature and salinity from the US Navy's Master Oceanographic Observational Data Set (MOODS).

For each acoustic model scenario, a single temperature/salinity profile was extracted from the GDEM database for the appropriate season and source location and converted to speed of sound in seawater using the equations of Coppens (1981):

$$
\begin{aligned}
c(z,T,S) &= 1449.05 + 45.7T - 5.21t^2 - 0.23t^3 \\
&\quad + (1.333 - 0.126t + 0.009t^2)(S - 35) + \Delta \\
\Delta &= 16.3Z + 0.18Z^2 \\
Z &= (z/1000)(1 - 0.0026\cos(2\phi)) \\
t &= T/10
\end{aligned}
$$

Here z is depth in meters, T is temperature in degrees Celsius, S is salinity in psu and φ is latitude (in radians).

The resulting sound speed profiles for the study area are shown in Figure 5, for the month of January. Note that the sound speed profile will vary seasonally. As terminal operations will occur year-round, and construction activities will cover several months, this has the potential to produce seasonal variations in the impacts from underwater noise associated with the DWP. January was selected as a "worst-case" month for offshore operations, as the cooler temperatures and decreased stratification will produce a sound speed profile which will tend to reduce refraction of sound into the bottom and thus reduce transmission loss. In contrast, the July profile for the offshore region is more downward-refracting

(Figure 6). In order to test the effect of these seasonal variations on received sound levels, selected model scenarios were run for both January and July sound speed profiles.

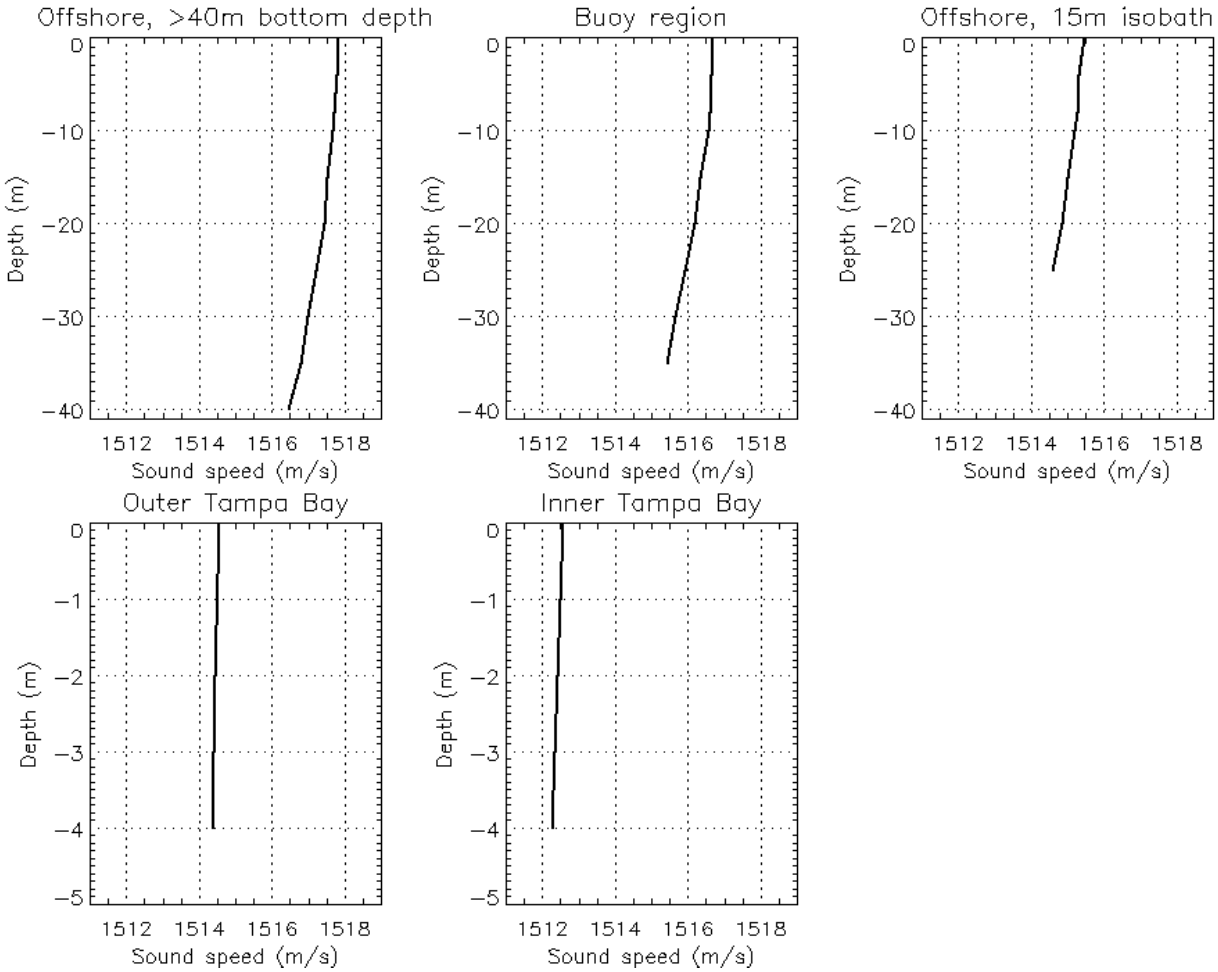

Figure 5: Predicted sound speed profiles for the month of January, from GDEM version 3.0 (Teague *et al.,* 1990).

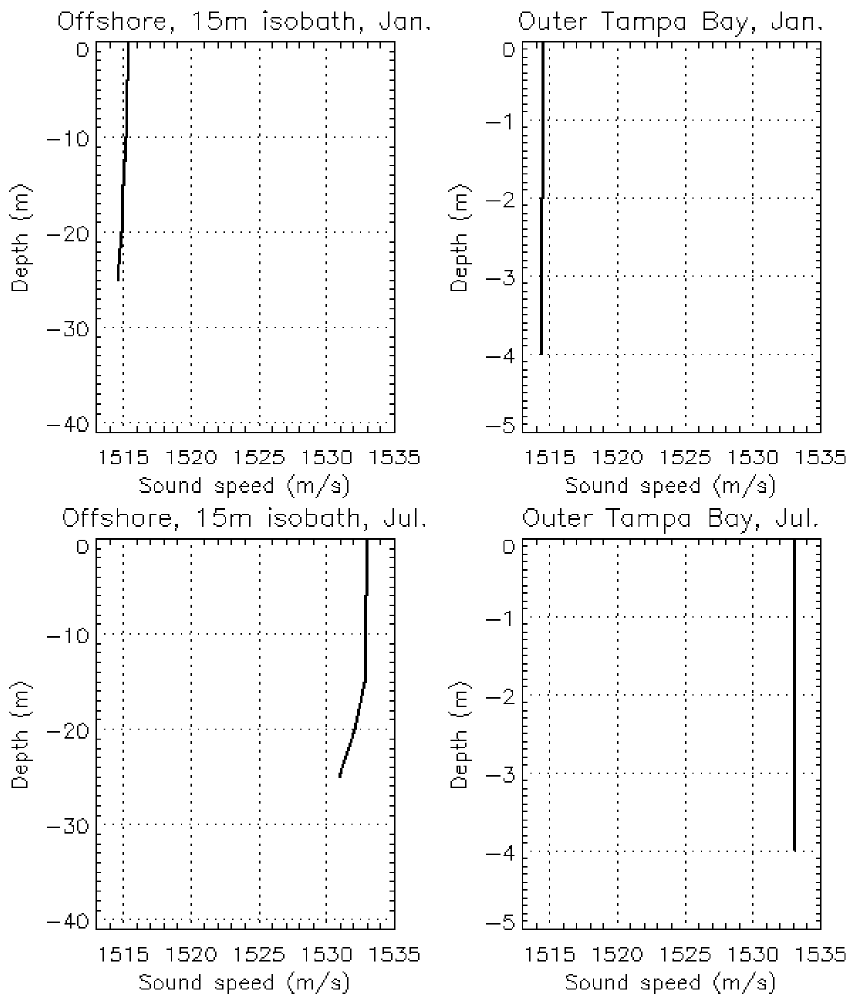

Figure 6: Predicted sound speed profiles for the months of January and July, from GDEM version 3.0 (Teague *et al.,* 1990).

5 Model Results

The MONM propagation model was run in the full n × 2-D sense as described in Section 3. Geographically rendered maps of the estimated received sound levels are shown in Appendix B for each of the scenarios described in Section 2. The tables in the following sub-sections summarize the results of the acoustic modeling in terms of radii to threshold values of 120 dB to 190 dB RMS. In addition, the threshold levels relevant to NMFS criteria for Level A and Level B harassment are highlighted. Note that the radial resolution of the model runs was 10 m.

For an impulsive source such as impact hammering, the acoustic level values in the model output represent the SEL metric, a suitable measure of the impact of an impulsive sound because it reflects the total acoustic energy delivered over the duration of the event at a receiver location. In order to determine the RMS SPL, a pulse duration of 0.1 s was assumed, resulting in a conversion factor of +10 dB (Section 3.1). Thus, RMS levels (in dB re 1μPa) were taken to be 10 dB higher than SEL values (in dB re $1\mu Pa^2 \cdot s$). This conversion is not required for continuous noise sources (vessel noise, plowing), for which the model outputs RMS values.

For each sound level threshold, the tables below list the 95% radius. Given a regularly gridded spatial distribution of modeled received levels, the 95% radius is defined as the radius of a circle that encompasses 95% of the grid points whose value is equal to or greater than the threshold value. This definition is meaningful in terms of potential impact to an animal because, regardless of the geometrical shape of the noise footprint for a given threshold level, it always provides a range beyond which no more than 5% of a uniformly distributed population would be exposed to sound at or above that level. Modeled sound levels were sampled at several depths at each site, up to the seafloor depth. The tables list radii based on maximum received levels over these ranges of depths.

Note that for some scenarios, higher threshold values only occur in the vicinity of individual pieces of equipment, with relatively little overlap of the sound fields from neighboring vessels. In these cases the overall radius depends primarily on the spacing between the vessels, and a single scenario-specific radius cannot sensibly be defined. For example, in the case of pipe laying in Passage Key (Figure 7 below), contour levels greater than 160 dB only occur in the immediate vicinity of the barge and tugs. In the tables that follow, such a situation is indicated by an entry such as “<0.2 km”.

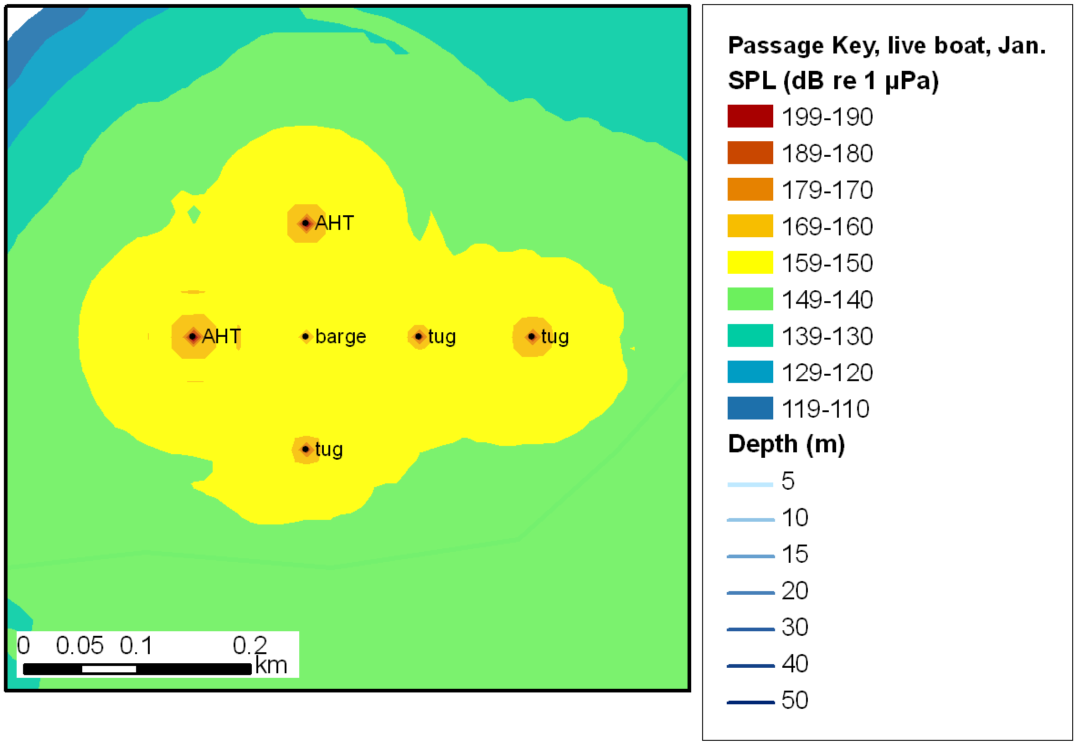

Figure 7: Estimated received sound levels near the sources, for pipe laying in Passage Key (see also Figure 12 in Appendix B). Note that “AHT” refers to an anchor-handling tug, while “tug” refers to a tug whose propulsion system is active but which is not actively pushing or pulling.

5.1 Un-Weighted Model Results

Raw model results, i.e. without application of M-weightings (see Section 3.2), are presented in the following two sub-sections.

5.1.1 Construction Scenarios

Radii to various threshold values are shown below for construction activities occurring in the offshore (Table 8) and inshore (Table 9) regions. See also Figure 8 through Figure 15 in Appendix B. Impact hammering is by far the loudest of the activities. However, it will likely occur only during relatively brief periods of time. Radii for pipe laying and burial are similar to one another, on the order of 6-8 km for the 120 dB contour and less than the equipment spacing for the 180 dB contour (Table 8, Table 9). Note that radii for a given activity vary with water depth; for example, the radius to the 120 dB contour during pipe laying varies from 7.5 km offshore (water depth of 15 m) to a mere 1.6 km in Passage Key (water depth less than 5 m). This is primarily due to the dramatically reduced transmission of lower-frequency sounds in shallower waters. For example, in the region of the Passage Key site the water depths are less than a single wavelength for frequencies up to at least a few hundred Hz ($f=c/\lambda$). Considering Figure 2 in Section 2.2, we see that most of the energy from the vessels associated with pipe laying occurs at these low frequencies, and so will propagate poorly.

Table 8: 95th percentile radii for offshore construction scenarios. See Figure 1 for site locations. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics. Note that radii for threshold values up to 140 dB exceeded the model bounds for impact hammering.

SPL (dB re 1 μPa)	95th percentile radius (km)			
	Buoy installation	**Impact hammering**	**Pipe laying**	**Pipe burial**
120	***3.9***	>20	***7.5***	***8.4***
130	1.4	>20	3.8	3.9
140	0.35	>20	2.0	2.0
150	<0.20	14.4	0.52	0.59
160	<0.20	***4.5***	<0.20	<0.20
170	<0.20	1.1	<0.20	<0.20
180	***<0.20***	***0.18***	***<0.20***	***<0.20***
190	***<0.20***	***0.03***	***<0.20***	***<0.20***

Table 9: 95th percentile radii for inshore construction scenarios. See Figure 1 for site locations. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics.

SPL (dB re 1 μPa)	95th percentile radius (km)			
	Impact hammering	**Pipe laying: Passage Key**	**Pipe laying: Tampa Bay**	**Pipe burial: Tampa Bay**
120	18.3	***1.6***	***6.0***	***6.7***
130	12.3	0.95	2.1	2.4
140	8.0	0.49	0.89	0.98
150	3.7	0.24	0.39	0.44
160	***1.9***	<0.21	<0.20	<0.20
170	0.85	<0.20	<0.20	<0.20
180	***0.30***	***<0.20***	***<0.20***	***<0.20***
190	***0.07***	***<0.20***	***<0.20***	***<0.20***

5.1.2 Operational Scenarios

Radii to various threshold values are shown in Table 10 below for transit, buoy approach, and docking of an SRV. See also Figure 16 through Figure 18 in Appendix B. Radii are similar for the transit and docking scenarios, i.e. 3.6-3.8 km for the 120 dB contour. As might be expected given the relative source levels (Figure 4 in Section 2.2.5), radii are considerably less for the approach scenario, during which main propulsion is at half speed and thrusters are not yet in operation.

Table 10: 95th percentile radii for operational scenarios. See Figure 1 for site locations. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics. Note that values are not shown for threshold values higher than the source level.

SPL (dB re 1 μPa)	**95th percentile radius (km)**		
	SRV transit	**SRV buoy approach**	**SRV docking**
120	***3.8***	***1.7***	***3.6***
130	1.5	0.43	1.5
140	0.32	0.09	0.37
150	0.05	0.01	0.09
160	0.01	<0.01	0.01
170	<0.01	<0.01	<0.01
180	***<0.01***	***------***	***<0.01***
190	***------***	***------***	***------***

5.2 Weighting for Hearing Capabilities of Marine Mammals and Turtles

As discussed in Section 3.2, model results may be weighted to reflect the hearing capabilities of various marine species. Ninety-fifth percentile radii are shown in Table 8 through Table 13 below for various combinations of model scenarios and functional hearing groups, based on the study sites listed in Table 1 of Section 2.2 and the species distributions listed in Table 5 of Section 3.2.

Comparing the radii in the following tables with the un-weighted radii in the previous section, we see relatively little reduction after weighting for low-frequency cetaceans and pinnipeds, as might be expected given their relatively low values for f_{lo} (see Table 4 of Section 3.2). Note, however, that the actual hearing capabilities of sea turtles and manatees, for which these M-weightings are applied as precautionary approximations, are likely to be less. As a result, these radii likely represent over-estimates for these species. A greater reduction in 95th percentile radii is seen when weighting for mid-frequency cetaceans (which includes sperm whales and dolphins).

Table 11: 95th percentile radii for offshore construction scenarios, M-weighted for low- and mid-frequency cetaceans. See Table 8 for un-weighted radii. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics.

SPL (dB re 1 μPa)	**95th percentile radius (km)**			
	Buoy installation	**Impact hammering**	**Pipe laying**	**Pipe burial**
Low-frequency cetaceans				
120	***3.8***	>20	***7.4***	***8.3***
130	1.4	>20	3.6	3.8
140	0.35	>20	1.8	1.9
150	<0.20	14.3	0.51	0.55
160	<0.20	***4.5***	<0.20	<0.20
170	<0.20	1.1	<0.20	<0.20
180	***<0.20***	***0.18***	***<0.20***	***<0.20***
190	<0.01	0.03	<0.20	<0.20
Mid-frequency cetaceans				
120	***2.9***	>20	***6.8***	***7.9***
130	0.90	>20	2.2	2.7
140	0.22	>20	0.76	0.91
150	<0.20	11.1	0.24	0.28
160	<0.20	***3.1***	<0.20	<0.20
170	<0.20	0.72	<0.20	<0.20
180	***<0.01***	***0.10***	***<0.20***	***<0.20***
190	<0.01	0.01	<0.01	<0.01

Table 12: 95th percentile radii for inshore construction scenarios, M-weighted for low- and mid-frequency cetaceans and for pinnipeds. See Table 9 for un-weighted radii. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics. Note that both cetacean and pinniped criteria are shown for the pinniped M-weighting, as manatees do not clearly belong to either group for the purposes of harassment criteria.

SPL (dB re 1 μPa)	**95th percentile radius (km)**			
	Impact hammering	**Pipe laying: Passage Key**	**Pipe laying: Tampa Bay**	**Pipe burial: Tampa Bay**
Low-frequency cetaceans				
120	18.3	***1.6***	***6.0***	***6.7***
130	12.2	0.95	2.1	2.4
140	7.9	0.49	0.88	0.98
150	3.7	0.24	0.39	0.44
160	***1.9***	<0.21	<0.20	<0.20
170	0.85	<0.20	<0.20	<0.20
180	***0.30***	***<0.20***	***<0.20***	***<0.20***
190	0.07	<0.20	<0.20	<0.20
Mid-frequency cetaceans				
120	18.3	***1.5***	***5.9***	***6.6***
130	12.2	0.92	2.0	2.3
140	7.8	0.40	0.77	0.88
150	3.6	0.22	0.28	0.32
160	***1.7***	<0.21	<0.20	<0.20
170	0.70	<0.20	<0.20	<0.20
180	***0.20***	***<0.20***	***<0.20***	***<0.20***
190	0.04	<0.01	<0.01	<0.01
Pinnipeds (in water)				
120	18.3	***1.5***	***6.0***	***6.7***
130	12.3	0.94	2.1	2.4
140	7.9	0.45	0.84	0.94
150	3.7	0.23	0.34	0.39
160	***1.8***	<0.21	<0.20	<0.20
170	0.80	<0.20	<0.20	<0.20
180	***0.26***	***<0.20***	***<0.20***	***<0.20***
190	***0.06***	***<0.01***	***<0.01***	***<0.01***

Table 13: 95th percentile radii for operational scenarios, M-weighted for low- and mid-frequency cetaceans. See Table 10 for un-weighted radii. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics. Note that values are not shown for threshold values higher than the un-weighted source level.

SPL (dB re 1 μPa)	95th percentile radius (km)		
	SRV transit	SRV buoy approach	SRV docking
Low-frequency cetaceans			
120	***3.8***	***1.6***	***3.5***
130	1.5	0.40	1.5
140	0.31	0.09	0.34
150	0.04	0.01	0.08
160	0.01	<0.01	0.01
170	<0.01	<0.01	<0.01
180	***<0.01***	***------***	***<0.01***
190	------	------	------
Mid-frequency cetaceans			
120	***1.7***	***0.5***	***1.7***
130	0.37	0.11	0.41
140	0.05	0.01	0.10
150	0.01	<0.01	0.01
160	<0.01	<0.01	<0.01
170	<0.01	<0.01	<0.01
180	***<0.01***	***------***	***<0.01***
190	------	------	------

5.3 Sensitivity of Model Results to Environmental Parameters

As discussed in Sections 4.4 and 4.5, model results are sensitive to uncertainties and variations in the environmental parameters that are input to the model, including water column sound speed profiles and geoacoustic properties of the sea floor. In order to quantify the effects of these sources of uncertainty, MONM was run for a number of variations on the main setup described in the previous sections, using pipe laying as an example scenario (effects will be similar for other scenarios).

As expected given the seasonal variation in the water column sound speed profile (see Figure 6 in Section 4.5), radii to various thresholds are less in July than they are in January (Table 14). As a result, the assumption presented in Section 4.5 that January values would represent a seasonal “worst-case” appears to be valid.

Table 14: 95th percentile radii for inshore and offshore pipe laying, modeled using water column sound speed profiles from two different times of year (see Figure 6 in Section 4.5). Radii corresponding to Level A and Level B harassment criteria are shown in bold italics.

SPL (dB re 1 μPa)	95th percentile radius (km): Pipe laying			
	Offshore, January	**Offshore, July**	**Inshore, January**	**Inshore, July**
120	***7.5***	***6.9***	***6.0***	***5.5***
130	3.8	3.3	2.1	2.0
140	2.0	1.8	0.89	0.83
150	0.52	0.50	0.39	0.37
160	<0.20	<0.20	<0.20	<0.20
170	<0.20	<0.20	<0.20	<0.20
180	***<0.20***	***<0.20***	***<0.20***	***<0.20***
190	***<0.20***	***<0.20***	***<0.20***	***<0.20***

The model results were found to be sensitive to the presence or absence of an unconsolidated sand layer overlying the limestone basement (Table 15; see also Section 4.4.1). The effect is slightly more pronounced at the inshore site, where shallower water favors greater interaction with the bottom, hence magnifying the effect of changing the bottom characteristics. While adding even a thin sand layer significantly reduces the radii, particularly at the inshore site, the change produced by increasing the depth of the sand layer from 2.5 m to 5 m is relatively small (Table 15). Similarly, increasing the thickness of the sand layer even further to 10 m has no significant effect on the estimated radii. Varying the geoacoustic properties of the soft limestone layer and the depth of the interface between the two limestone layers (as discussed in Section 4.4.1) also fails to produce any significant changes in the modeled radii.

Table 15: 95th percentile radii for inshore and offshore pipe laying, modeled using a sand layer of varying thickness (see Section 4.4.1). Radii corresponding to Level A and Level B harassment criteria are shown in bold italics.

SPL (dB re 1 μPa)	95th percentile radius (km): Pipe laying					
	Offshore, no sand	**Offshore, 2.5 m sand layer**	**Offshore, 5 m sand layer**	**Inshore, no sand**	**Inshore, 2.5m sand layer**	**Inshore, 5 m sand layer**
120	***11.8***	***7.8***	***7.5***	***9.1***	***6.0***	***6.0***
130	4.8	4.0	3.8	3.6	2.2	2.1
140	2.0	2.0	2.0	1.5	0.96	0.89
150	0.72	0.62	0.52	0.67	0.45	0.39
160	<0.20	<0.20	<0.20	0.22	<0.20	<0.20
170	<0.20	<0.20	<0.20	<0.20	<0.20	<0.20
180	***<0.20***	***<0.20***	***<0.20***	***<0.20***	***<0.20***	***<0.20***
190	***<0.20***	***<0.20***	***<0.20***	***<0.20***	***<0.20***	***<0.20***

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Appendix A: Source Levels

SOURCE LEVELS

The third-octave band source levels input to the acoustic propagation model for various pieces of equipment are listed in Table 16 through Table 18 below. Their use is discussed further in Section 2.

Table 16: Third-octave band source levels for vessels involved in construction-related modeling scenarios (see Section 2.2). Source depths are 2.2 m and 3 m for the Castoro II and Britoil 51, respectively.

Frequency (Hz)	Castoro II (barge), anchor operations	Castoro II (barge), pipe laying	Britoil 51 (tug), anchor operations	Britoil 51 (tug), transiting
10	175.6	164.7	202.8	188.7
12.5	170.0	166.2	196.5	182.7
16	162.7	162.7	193.1	174.1
20	158.3	165.5	191.1	167.5
25	151.8	169.0	196.7	165.2
31.5	149.1	159.6	188.8	172.2
40	146.6	156.2	177.3	182.2
50	147.9	157.7	176.4	170.2
63	153.3	154.3	179.2	167.1
80	153.2	152.2	178.8	164.9
100	156.4	153.0	178.1	161.8
125	162.2	159.8	176.7	166.0
160	155.6	152.5	175.9	167.6
200	151.4	149.8	173.5	167.5
250	151.7	152.2	178.8	164.8
315	143.6	142.4	172.8	165.2
400	145.2	147.2	165.4	165.2
500	145.8	144.8	170.7	169.8
630	145.5	142.7	168.8	159.9
800	150.5	147.5	165.1	158.6
1000	150.8	148.7	164.2	163.6
1250	142.7	141.7	167.3	161.0
1600	138.6	136.1	165.9	164.9
2000	143.2	139.3	166.5	164.2
Broadband	**177.2**	**173.9**	**205.2**	**190.8**

Table 17: Third-octave band source levels for non-vessel activities involved in construction-related modeling scenarios (see Section 2.2). Source depth for the impact hammer is half the local water depth; source depth for the dredge is 2.2 m.

Frequency (Hz)	**Impact hammer**	**Aquarius dredge**
10	202.0	153.0
12.5	202.0	153.0
16	192.0	153.0
20	187.0	153.0
25	184.0	165.0
31.5	186.0	162.0
40	188.0	169.0
50	184.0	172.0
63	188.0	171.0
80	198.0	172.0
100	200.0	179.0
125	204.0	178.0
160	208.0	180.0
200	209.5	179.0
250	209.0	177.0
315	204.0	177.0
400	204.5	176.0
500	205.0	173.0
630	198.0	170.0
800	195.0	169.0
1000	194.0	169.0
1250	195.0	169.0
1600	194.0	169.0
2000	192.0	169.0
Broadband	**216.2**	**187.7**

Table 18: Third-octave band source levels for operational modeling scenarios (see Section 2.2). Source levels for docking include main SRV propulsion at dead slow, two bow thrusters, and one stern thruster. Source depth is 6 m in all cases.

Frequency (Hz)	**SRV, full speed transit**	**SRV, half speed transit**	**SRV, docking**
10	171.0	162.4	171.5
12.5	171.0	162.4	171.5
16	171.0	162.4	171.5
20	171.0	162.4	171.5
25	171.0	162.4	171.5
31.5	171.0	162.4	171.5
40	171.0	162.4	171.5
50	171.0	162.4	171.5
63	171.0	162.4	171.5
80	171.0	162.4	171.5
100	171.0	162.4	171.5
125	169.1	160.5	169.6
160	167.0	158.4	167.4
200	165.0	156.4	165.5
250	163.1	154.5	163.6
315	161.1	152.5	161.6
400	159.0	150.4	159.5
500	157.1	148.5	157.5
630	155.1	146.5	155.5
800	153.0	144.4	153.5
1000	151.0	142.4	151.5
1250	149.1	140.5	149.6
1600	147.0	138.4	147.4
2000	145.0	136.4	145.5
Broadband	**182.1**	**173.5**	**182.6**

Appendix B: Sound Maps

SOUND MAPS

Sound field maps are shown below for each of the scenarios described in Section 2 (see summaries in Table 1 and Figure 1). At each point within the sound field, maximum sound levels are selected over all modeled depths, down to the local bottom depth. In the case of the impact hammer, which is an impulsive source, SPL_{RMS} values were estimated from the SEL values output by the model by the addition of 10 dB (see Section 3.1). Model results are discussed further in Section 5.

Buoy Installation

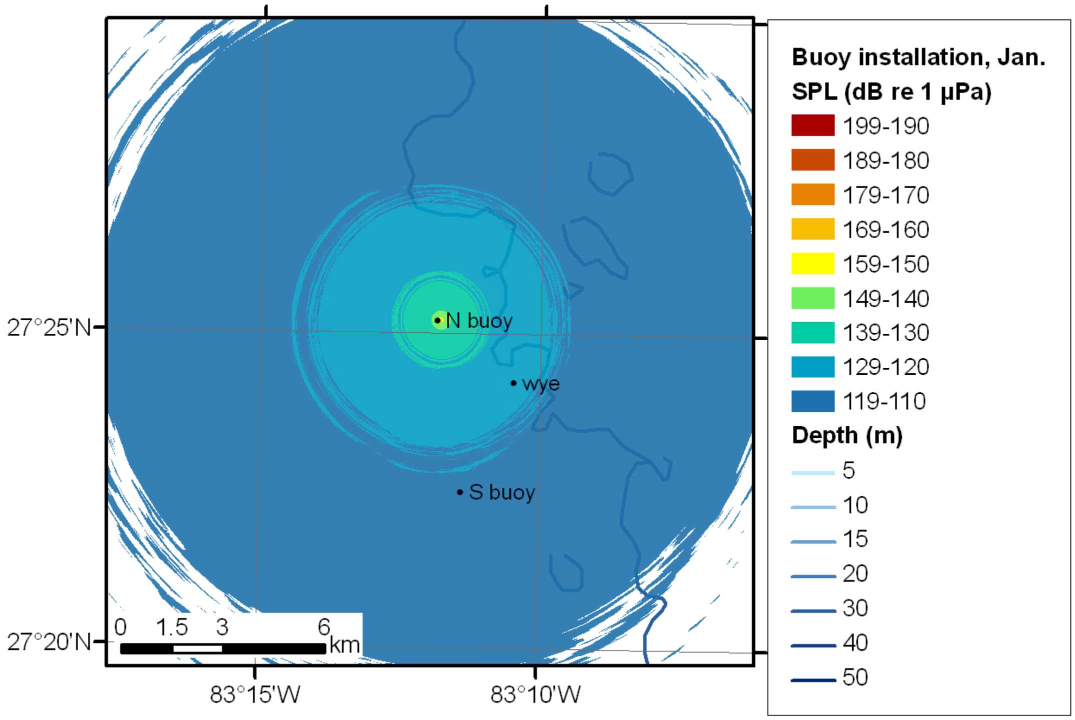

Figure 8: Estimated received sound levels for activities related to installation of the north anchor buoy (see Table 1, Section 2.2.1).

Impact Hammering

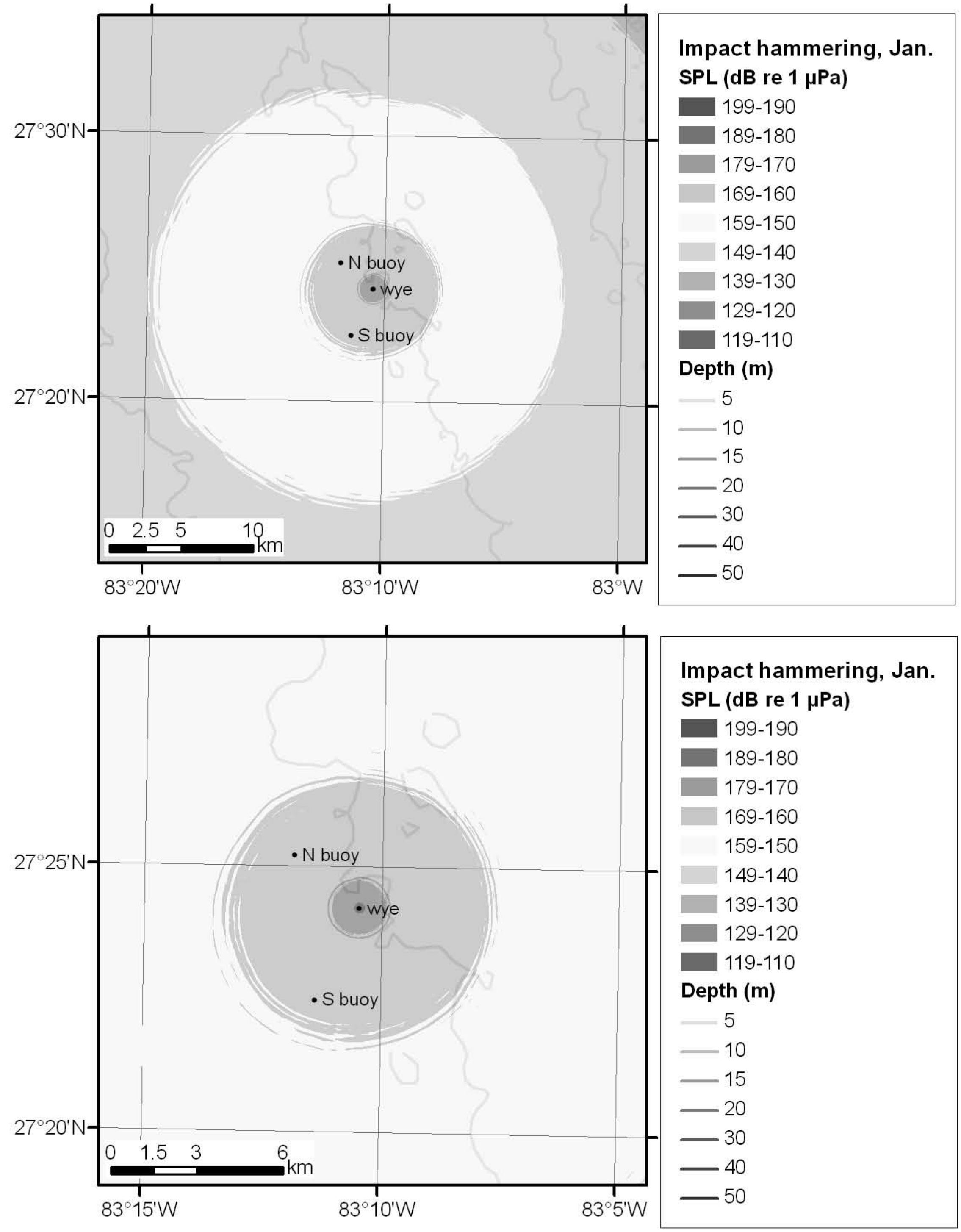

Figure 9: Estimated received sound levels for impact hammering at the piggable wye (see Table 1, Section 2.2.2). The lower panel is a zoomed-in (2x) version of the upper panel.

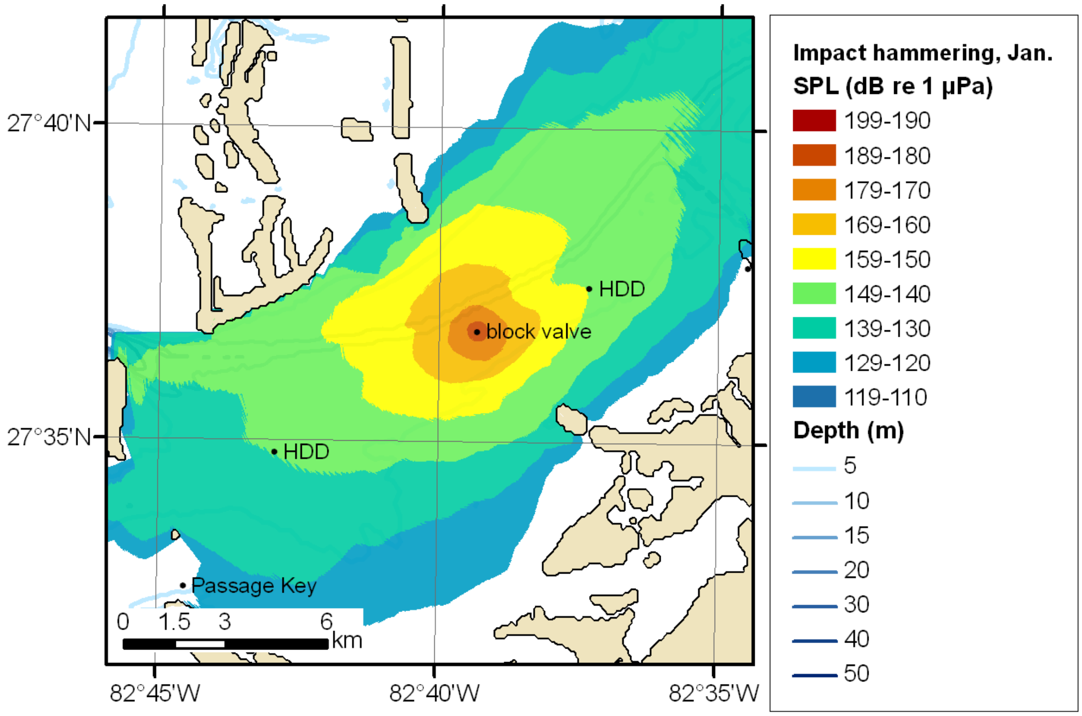

Figure 10: Estimated received sound levels for impact hammering at the subsea block valve (see Table 1, Section 2.2.2).

Pipe Laying

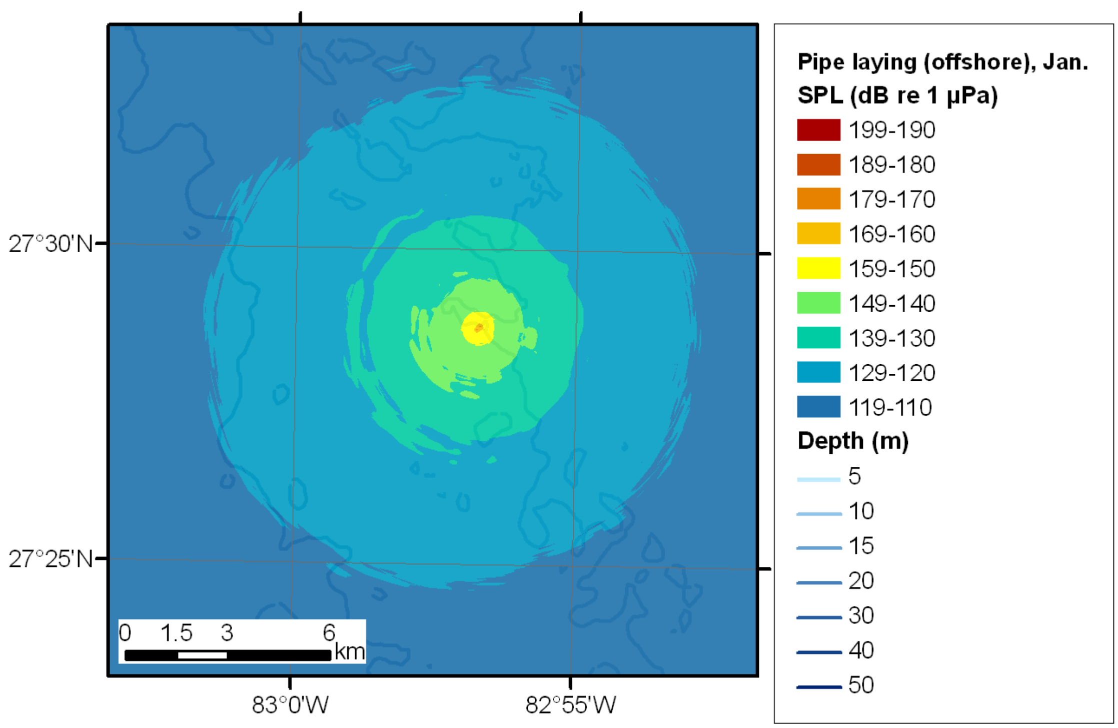

Figure 11: Estimated received sound levels for offshore pipe laying (see Table 1, Section 2.2.3).

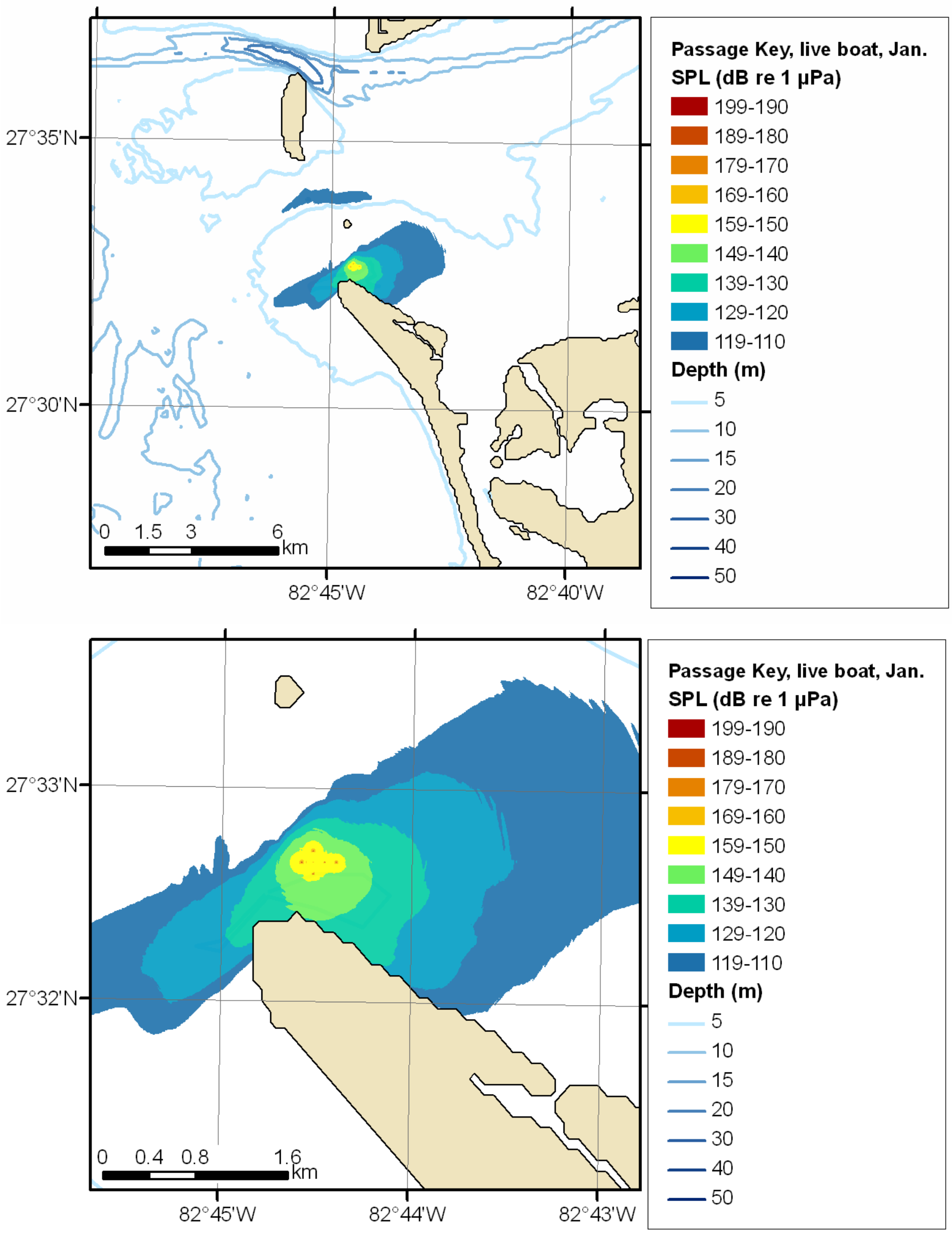

Figure 12: Estimated received sound levels for pipe laying in Passage Key (see Table 1, Section 2.2.3). The lower panel is a zoomed-in version of the upper panel.

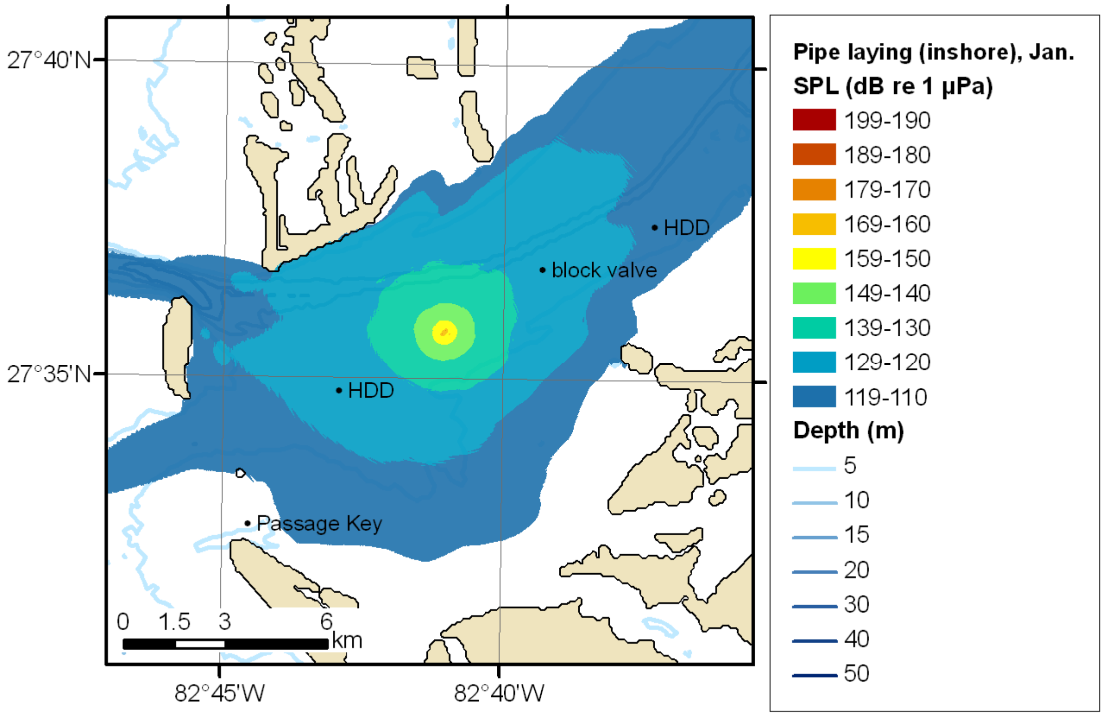

Figure 13: Estimated received sound levels for inshore pipe laying (see Table 1, Section 2.2.3).

Pipe Burial

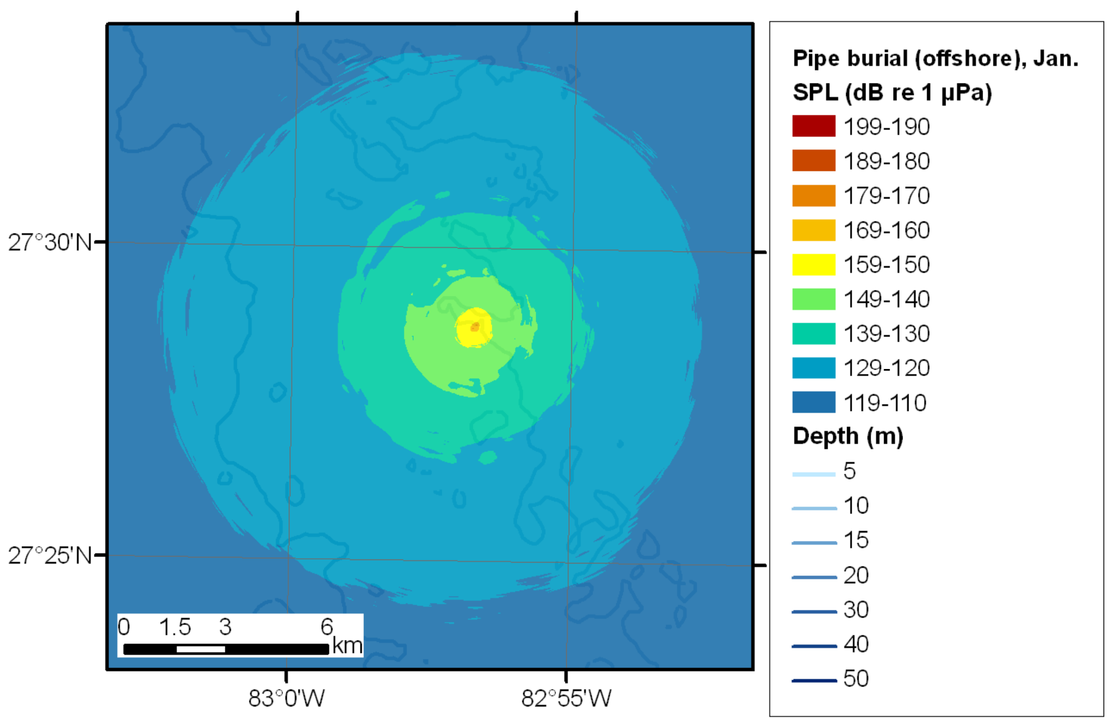

Figure 14: Estimated received sound levels for offshore pipe burial (see Table 1, Section 2.2.4).

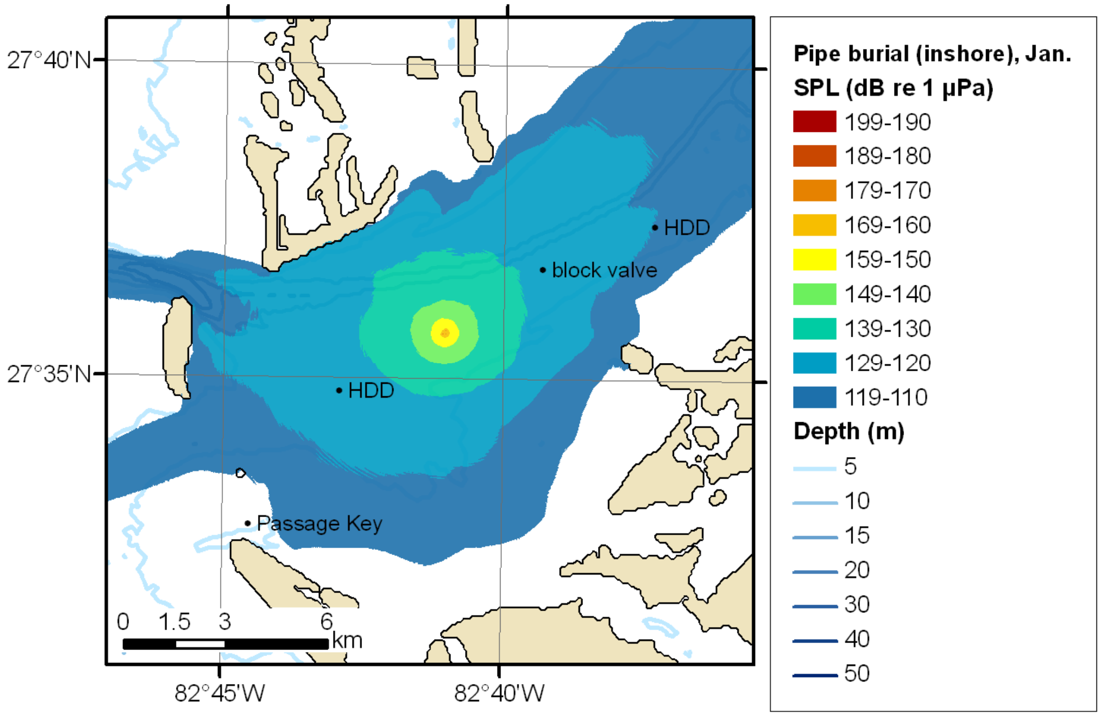

Figure 15: Estimated received sound levels for inshore pipe burial (see Table 1, Section 2.2.4).

Operational Scenarios

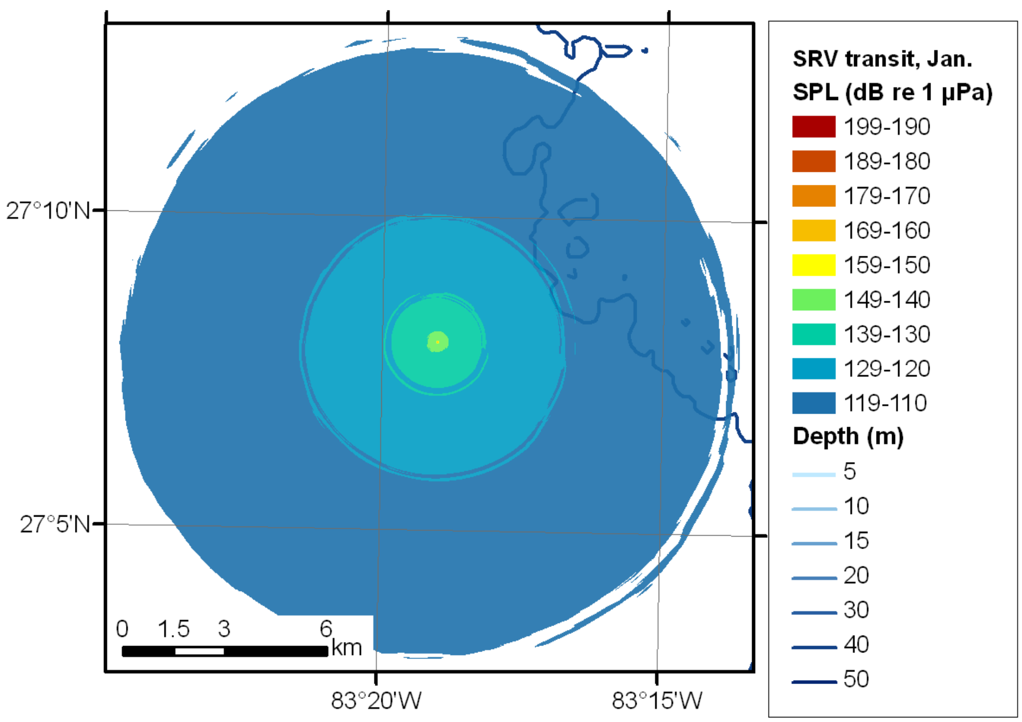

Figure 16: Estimated received sound levels for SRV transit (see Table 1, Section 2.2.5).

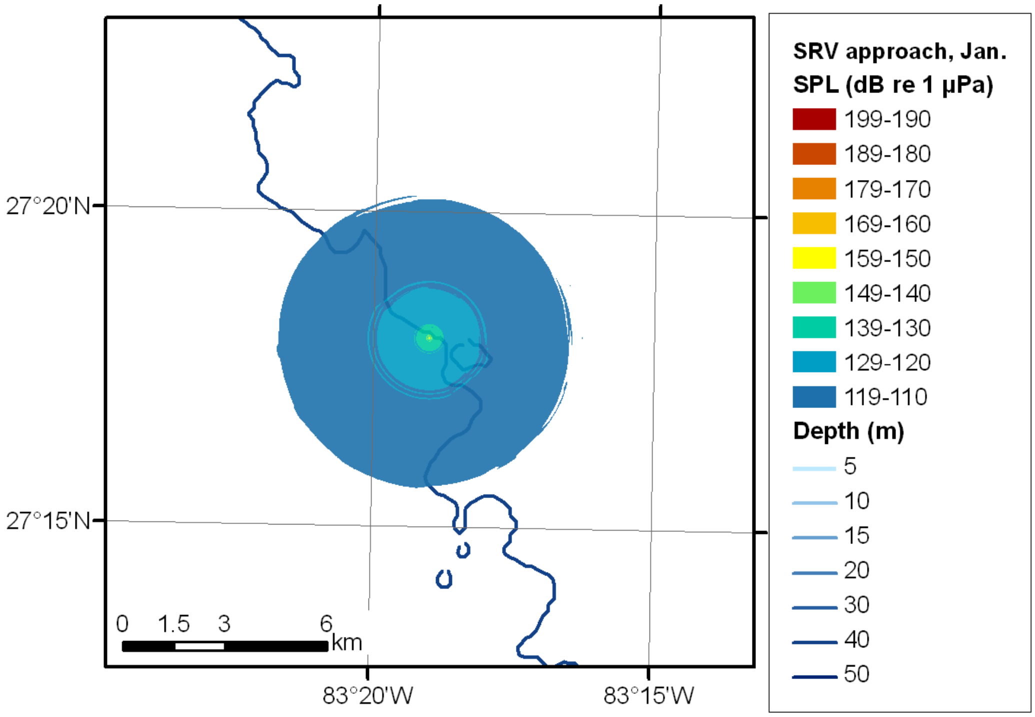

Figure 17: Estimated received sound levels for SRV approach (see Table 1, Section 2.2.5).

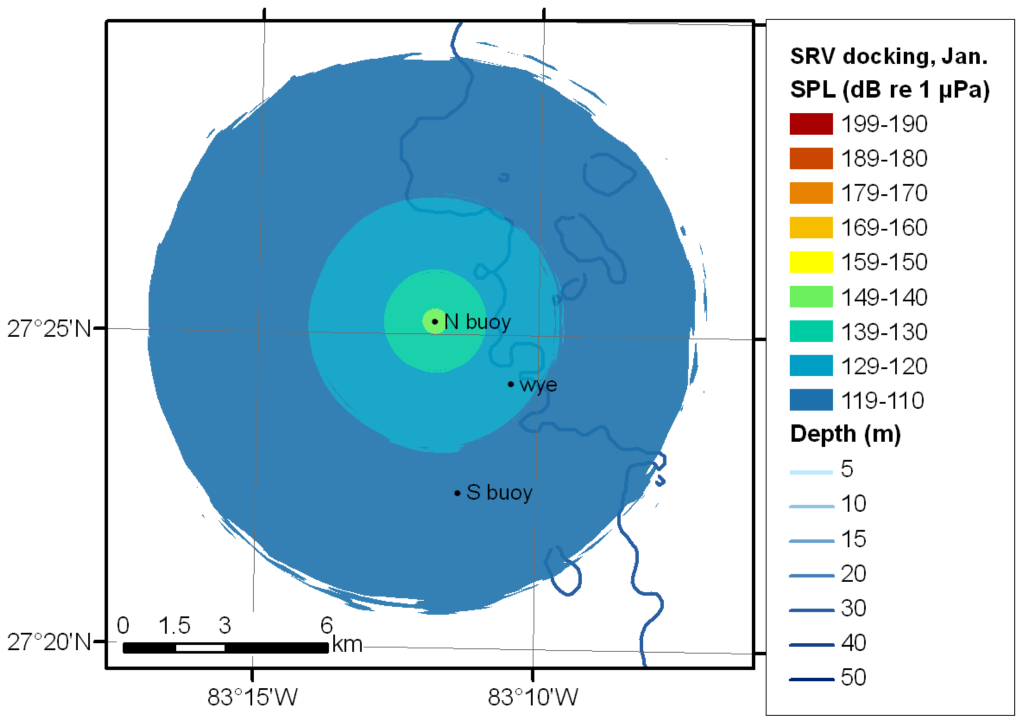

Figure 18: Estimated received sound levels for SRV docking (see Table 1, Section 2.2.5).

Appendix C: LGL Marine Mammal Impact Report

ASSESSMENT OF THE EFFECTS OF UNDERWATER NOISE FROM THE PROPOSED PORT DOLPHIN ENERGY LNG DEEP WATER PORT PROJECT

By

LGL LIMITED
environmental research associates

for

CSA International, Inc.

8502 SW Kansas Ave

Stuart, FL 34997

772-219-3000

LGL Report No. TA4606

23 January 2008

ASSESSMENT OF THE EFFECTS OF UNDERWATER NOISE FROM THE PROPOSED PORT DOLPHIN ENERGY LNG DEEP WATER PORT PROJECT

By

Rolph A. Davis

LGL Limited

P.O. Box 258, 22 Fisher St.

King City, ON L7B 1K4

905-833-1244

radavis@lgl.com

for

CSA International, Inc.

8502 SW Kansas Ave

Stuart, FL 34997

772-219-3000

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ASSESSMENT OF THE EFFECTS OF UNDERWATER NOISE FROM THE PROPOSED PORT DOLPHIN LNG PROJECT

The details of the proposed Port Dolphin LNG project are discussed elsewhere in this application. The relevant aspects are summarized later in this assessment. The proposed project activities during construction and operation will introduce noise into the water column, which may affect marine animals. The potential for those effects to occur and their significance are addressed in this assessment.

Two groups of marine animals are considered: marine mammals (toothed whales and Florida manatees) and sea turtles. The assessment consists of four parts. (1) The first part of the assessment summarizes other parts of the Application that discuss species and numbers in each group that are present in the area likely to be influenced by the project. This is followed by (2) a review of the known effects of the types of noise emanating from the Port Dolphin project based on information from other studies. Part (3) refers to an acoustic analysis of the source levels of the various project noises followed by modelling of the propagation of the noises out from the source. Finally, (4) the propagation results are combined with the animal density data to determine the numbers of animals that might be exposed to the noise. This is followed by an assessment of potential effects based on the known responses of these animals as determined in other studies.

(1) Numbers and Species of Animals Present

A detailed analysis of the marine mammals and sea turtles that occur in the northeastern Gulf of Mexico is presented in Chapter 4 of Volume II of this Deepwater Port License Application. The data in that section are used as the basis for the assessment of the effects of underwater noise in the following sections.

From Chapter 4. Three marine mammals are most likely to occur in the project area. Bottlenose dolphins and Atlantic spotted dolphins are likely to be present in continental shelf and coastal waters, including the STL buoy locations and along the pipeline route. The Florida manatee occurs primarily in coastal waters within Tampa Bay and would not be expected to occur at the STL buoy locations or along open water, offshore portions of the pipeline route. The Florida manatee is an endangered species, whereas the bottlenose dolphin and Atlantic spotted dolphin are not endangered or threatened. The cetacean fauna of the northern Gulf of Mexico's continental shelf, including the project area, typically consists of the bottlenose dolphin and the Atlantic spotted dolphin (Davis et al. 1998; Davis et al. 2000üü). Along the shelf edge and within the deeper waters of the continental slope, the cetacean community typically includes 19 species.

In addition to marine mammals, there are five species of marine or sea turtles that occur in the eastern Gulf of Mexico: loggerhead, green, hawksbill, Kemp's ridley, and leatherback.

Relevant aspects of the hearing capabilities and the known responses to underwater noise for the key species are discussed in the next section.

(2) Known Effects of Underwater Noise from Project Activities

Marine Mammals

Marine mammals rely heavily on the use of underwater sounds to communicate and gain information about their environment. The reactions of marine mammals to noise can be variable and depend on the species involved, time of year, and the activity of the animal at the time of exposure to noise. Because underwater noise sometimes propagates for long distances, the radius of audibility can be large for a strong noise. However, marine mammals usually do not respond overtly to audible, but weak, man-made sounds (Richardson et al. 1995). Thus, the zone of "responsiveness" is usually much smaller than the zone of audibility. Potential effects of noise on marine mammals include masking, disturbance (behavioral), hearing impairment (temporary threshold shift [TTS] and permanent threshold shift [PTS]), and non-auditory physiological effects.

Masking

Masking is the obscuring of sounds of interest by other sounds, often at similar frequencies. Marine mammals are highly dependent on sound, and their ability to recognize sound signals amid noise is important in communication, predator and prey detection, and, in the case of toothed whales, echolocation.

Even in the absence of man-made sounds, the sea is usually noisy. Background ambient noise often interferes with or masks the ability of an animal to detect a sound signal even when that signal is above its absolute hearing threshold. Natural ambient noise includes contributions from wind, waves, precipitation, other animals, and (at frequencies above 30 kHz) thermal noise resulting from molecular agitation (see Chapter 5 of Richardson et al. 1995). Background noise can also include sounds from distant human activities such as shipping. This is particularly true in the Tampa Bay area where there is heavy ship and boat traffic. Masking of natural sounds can result when human activities produce high levels of background noise. Conversely, if the background level of underwater noise is high (e.g., on a day with strong wind and high waves), an anthropogenic noise source will not be detectable as far away as would be possible under quieter conditions, and will itself be masked. Ambient noise is highly variable on continental shelves (e.g., Thompson 1965; Myrberg 1978; Chapman et al. 1998; Desharnais et al. 1999). This inevitably results in a high degree of variability in the range at which marine mammals can detect anthropogenic sounds.

Although masking is a natural phenomenon to which marine mammals must be adapted, introduction of strong sounds into the sea at frequencies important to marine mammals will inevitably increase the severity and the frequency of occurrence of masking. For example, if a baleen whale is exposed to continuous low-frequency noise from an industrial source, this will reduce the size of the area around that whale within which it will be able to hear the calls of another whale. In general, little is known about the importance to marine mammals of detecting sounds from conspecifics, predators, prey, or other natural sources. In the absence of much information about the importance of detecting these natural sounds, it is not possible to predict the impacts if mammals are unable to hear these sounds as often, or from as far away, because of masking by industrial noise (Richardson et al. 1995). In general, masking effects are expected to be less severe when sounds are transient than when they are continuous. Also, human-induced masking is likely to be less severe for species that hear best at higher frequencies (e.g. dolphins) than for baleen whales that hear best at the low frequencies dominated by industrial sounds.

Although some degree of masking is inevitable when high levels of man-made broadband sounds are introduced into the sea, marine mammals have evolved systems and behavior that function to reduce the impacts of masking. Structured signals such as the echolocation click sequences of small toothed whales may be readily detected even in the presence of strong background noise because their frequency content and temporal features usually differ strongly from those of the background noise (Au and Moore 1988; 1990). It is primarily the components of background noise that are similar in frequency to the sound signal in question that determine the degree of masking of that signal. Low-frequency industrial noise, such as shipping, has little or no masking effect on high-frequency echolocation sounds. Redundancy and context can also facilitate detection of weak signals. These phenomena may help marine mammals detect weak sounds in the presence of natural or man-made noise.

Most masking studies in marine mammals present the test signal and the masking noise from the same direction. The sound localization abilities of marine mammals suggest that, if signal and noise come from different directions masking would not be as severe as the usual types of masking studies might suggest (Richardson et al. 1995). The dominant background noise may be highly directional if it comes from a particular anthropogenic source such as a ship or industrial site. Directional hearing may significantly reduce the masking effects of these noises by improving the effective signal-to-noise ratio. In the cases of high-frequency hearing by the bottlenose dolphin (*Tursiops truncatus*), beluga whale (*Delphinapterus leucas*), and killer whale (*Orcinus orca*), empirical evidence confirms that masking depends strongly on the relative directions of arrival of sound signals and the masking noise (Penner et al. 1986; Dubrovskiy 1990; Bain et al. 1993; Bain and Dahlheim 1994).

Toothed whales, and probably other marine mammals as well, have additional capabilities besides directional hearing that can facilitate detection of sounds in the presence of background noise. There is evidence that some toothed whales can shift the dominant frequencies of their echolocation signals from a frequency range with much ambient noise toward frequencies with less noise (Au et al. 1974, 1985; Moore and Pawloski 1990; Thomas and Turl 1990; Romanenko and Kitain 1992; Lesage et al. 1999). A few marine mammal species are known to increase the source levels of their calls in the presence of elevated sound levels (Dahlheim 1987; Au 1993; Lesage et al. 1999; Terhune 1999).

These data demonstrating adaptations for reduced masking pertain mainly to the very high-frequency echolocation signals of toothed whales. There is less information about the existence of corresponding mechanisms at moderate or low frequencies, or in other types of marine mammals. For example, Zaitseva et al. (1980) found that, for the bottlenose dolphin, the angular separation between a sound source and a masking noise source had little effect on the degree of masking when the sound frequency was 18 kHz, in contrast to the pronounced effect at higher frequencies. Directional hearing has been demonstrated at frequencies as low as 0.5-2 kHz in several marine mammals, including killer whales (see Section 8.4 in Richardson et al. 1995). This ability may be useful in reducing masking at these frequencies.

In summary, high levels of noise generated by anthropogenic activities may act to mask the detection of weaker biologically important sounds by some marine mammals. This masking would be more prominent for lower frequencies. For higher frequencies, such as used in echolocation by toothed whales, several mechanisms are available that may allow them to reduce the effects of such masking.

Disturbance

Disturbance can induce a variety of effects, such as subtle changes in behavior, more conspicuous dramatic changes in activities, and displacement. Disturbance is one of the main concerns of the potential impacts of man-made noise on marine mammals. Behavioral reactions of marine mammals to sound are difficult to predict because they are dependent on numerous factors including species, state of maturity, experience, current activity, reproductive state, time of day, and weather state. If a marine mammal does react to an underwater sound by changing its behavior or moving a small distance, the impacts of that change may not be important to the individual, the stock, or the species as a whole. However, if a sound source displaces marine mammals from an important feeding or breeding area for a prolonged period, impacts on the animals could be important.

Based on the literature reviewed in Richardson et al. (1995), it is apparent that most small and medium-sized toothed whales exposed to prolonged or repeated, underwater sounds are unlikely to be displaced unless the overall received level is at least 140 dB re 1 µPa. The limited available data indicate that the sperm whale (*Physeter macrocephalus*) is sometimes, though not always, more responsive than other toothed whales. Baleen whales probably have better hearing sensitivities at lower sound frequencies, and in several studies have been shown to react at received sound levels of approximately 120 dB re 1 µPa.

Toothed whales appear to exhibit a greater variety of reactions to man-made underwater noise than do baleen whales. Toothed whale reactions can vary from approaching vessels (e.g., to bow ride) to strong avoidance.

Hearing Impairment

Temporary or permanent hearing impairment is a possibility when marine mammals are exposed to very strong sounds. The minimum sound level necessary to cause permanent hearing impairment is higher, by a variable and generally unknown amount, than the level that induces barely detectable temporary hearing loss or temporary threshold shift (TTS). The level associated with the onset of TTS is often considered to be a level below which there is no danger of permanent damage. Current NMFS policy regarding exposure of marine mammals to high-level sounds is that cetaceans and pinnideds should not be exposed to impulsive sounds exceeding 180 and 190 dB re 1 µPa (rms), respectively (NMFS 2000).

Temporary Threshold Shift

TTS is the mildest form of hearing impairment. It is the process whereby exposure to strong sound results in a non-permanent elevation in hearing threshold making it more difficult to hear sounds (Kryter 1985). TTS can last from minutes or hours to days. The magnitude of the TTS depends on the level and duration of the noise exposure, among other considerations (Richardson et al. 1995). For sound exposures at or somewhat above the TTS level, hearing sensitivity recovers rapidly after exposure to the noise ends. TTS commonly occurs in mammals, including humans.

Only a few data on sound levels and durations necessary to elicit mild TTSs have been obtained for marine mammals, and all of these data are quite recent. TTS studies in humans and terrestrial mammals provide information helpful in understanding general principles of TTS, but it is unclear to what extent these data can be extrapolated to marine mammals.

Permanent Threshold Shift

There are no data on noise levels that might induce permanent hearing impairment in marine mammals. In theory, physical damage to a marine mammal's hearing apparatus could occur immediately if it is exposed to sound impulses that have very high peak pressures, especially if they have very short rise times. Also, very prolonged exposure to a noise strong enough to elicit a TTS, or shorter-term exposure to noise levels well above the TTS level, could cause hearing injury. Such damage can result in a permanent decrease in functional sensitivity of the hearing system at some or all frequencies. Richardson et al. (1995) hypothesized that permanent hearing impairment caused by prolonged exposure to continuous man-made noise is not likely to occur in marine mammals for sounds with source levels up to ~200 dB re 1 µPa-m.

Single or occasional occurrences of mild TTS do not cause permanent auditory damage in humans or other terrestrial mammals, and presumably do not do so in marine mammals. Sound impulse duration, peak amplitude, and rise time are the main factors thought to determine the onset and extent of PTS. Based on existing data, Ketten (1995) noted that the criteria for differentiating the sound pressure levels that result in a PTS (or TTS) are location and species specific. PTS effects may also be influenced strongly by the health of the receiver's ear.

For sound exposures at or somewhat above the TTS level, hearing sensitivity recovers rapidly after exposure to the noise ends. At least in terrestrial mammals, the received sound level from a single noise exposure must be far above the TTS level for there to be any risk of PTS (Kryter 1985, 1994; Richardson et al. 1995). Relationships between TTS and PTS levels have not been studied in marine mammals but are assumed to be similar to those in humans and other terrestrial mammals.

Non-Auditory Physiological Effects

Non-auditory physiological effects may also occur in marine mammals exposed to very strong underwater sound. Possible types of non-auditory physiological effects or injuries that, in theory, might occur, include stress, neurological effects, bubble formation, resonance effects, and other types of organ or tissue damage. It is possible that some marine mammal species (i.e., beaked whales) may be especially susceptible to injury and/or stranding when exposed to strongly pulsed sounds, particularly at higher frequencies. None of the activities associated with the Port Dolphin project will generate sounds loud enough to cause physiological effects.

Marine Mammal Hearing

Direct hearing measurements are available for only a few marine mammal species because of the difficulty of obtaining such measurements from free-living animals. The results of hearing studies in marine mammals that could occur in the Port Dolphin project area are presented below. It is generally thought that an animal's hearing range is likely to be related to the range of sounds that it produces. Evidence in support of this in marine mammals comes from the fact that the peak spectral frequencies of echolocation signals recorded in odontocetes are near the best frequencies of hearing for individuals of the same species for which behavioral audiograms have been recorded (Ketten 2000).

Odontocetes or toothed whales are considered to be high-frequency specialists, with peak spectra of their vocalizations ranging between 10 and 200 kHz (Ketten 2000). Most noise from the Port Dolphin project will be at low frequencies, well below the best hearing frequencies of the toothed whales. Hearing measurements have been made in several species of odontocete, including the bottlenose dolphin, which are rather well studied because of the availability of well-trained, captive individuals.

Bottlenose Dolphin (Tursiops truncatus)

The bottlenose dolphin was the first species of odontocete for which an audiogram was produced. Johnson (1967) measured the hearing sensitivity of a single 8- or 9-year old male bottlenose dolphin to frequencies ranging from 75 Hz to 150 kHz. That animal's greatest hearing sensitivity (45 dB re 1 μPa) was at about 50 kHz. Its hearing threshold at 75 Hz was 137 dB re 1 μPa and its hearing threshold at 150 kHz was 135 dB re 1 μPa, which was thought to be its effective upper frequency limit of hearing.

Au et al. (2002) measured the hearing sensitivity of a single 18-year-old female bottlenose dolphin using behavioral techniques and produced an audiogram remarkably similar to that of Johnson (1967). They also measured its hearing sensitivity to 2-second broadband signals with peak frequencies around 100 kHz, designed to simulate echoes from bottlenose dolphin echolocation signals. The measured hearing thresholds for these broadband signals were 33.9 ± 3.1 dB re 1 μPa^2 for a unimodal stimulus and 32.3 ± 2.8 dB re 1 μPa^2 for a bimodal stimulus, which were lower than those found using pure tone signals.

Turl (1993) measured the low-frequency hearing sensitivity of a bottlenose dolphin in the frequency range of 50–300 Hz. That dolphin's hearing thresholds at 300 and 200 Hz were similar to those reported by others, with signal detection at sound pressure levels approximately 10–15 dB above the ambient noise level. However, for frequencies from 50–150 Hz, after a few trials, the dolphin's sensitivity suddenly improved and she was able to detect signals near the ambient noise level. Turl suggested that the dolphin was detecting particle velocity or some combination of pressure and velocity rather than the acoustic stimulus itself at lower frequencies.

An eastern Pacific bottlenose dolphin (*Tursiops* spp.) captured near Baja California, Mexico, was found to have maximum hearing sensitivities at 25 kHz (47 dB) and 50 kHz (46 dB) (Ljungblad et al. 1982). That dolphin responded reliably to signals in the range of 2–135 kHz but did not respond to 136- to 160-kHz signals at sound pressure levels up to 120 dB re 1 μPa.

Ridgway and Carder (1997) presented evidence of individual variation in the hearing sensitivities of eight (four male and four female) bottlenose dolphins. Three of the male dolphins (aged 23, 26, and 34 years) had lost sensitivity to 70-, 80-, 100-, and 120-kHz tones, and one female dolphin was insensitive to 100- and 120-Hz tones. They also reported on one 9-year-old female bottlenose dolphin who did not respond to any sound when measured behaviorally and electrophysiologically. She also was unable to vocalize. Brill et al. (2001) reported age-related hearing loss in a 33-year-old male bottlenose dolphin. That dolphin had lost sensitivity to frequencies >55 kHz and his right ear was 16–33 dB less sensitive than his left ear in the 10–40-kHz range.

Atlantic Spotted Dolphin (*Stenella frontalis*)

This species produces underwater sounds that range from 0.1 Hz to 8 kHz. They are also able to produce ultrasounds when using echolocation (Richardson et al. 1995). Echolocation clicks have two dominant frequency ranges at 40 to 50 kHz and 110 to 130 kHz, depending on source level (i.e., lower source levels typically correspond to lower frequencies and higher frequencies to higher source levels (Au and Herzing 2003). Echolocation click source levels as high as 210 dB re 1 μPa-m peak-to-peak have been recorded (Au and Herzing 2003). There are no hearing data for Atlantic spotted dolphins. However, similar to other toothed whales, they probably have good hearing sensitivity at moderate and high frequencies (8–90 kHz), with diminishing sensitivity at progressively lower frequencies, and relatively poor sensitivity to low frequency sounds.

Florida Manatee (*Trichechus manatus*)

Manatees swim slowly just below or at the surface of the water, and thus they are vulnerable to boat collisions. The West Indian manatee is capable of hearing sounds from 15 Hz to 46 kHz, with the best sensitivity at 6 to 20 kHz (Gerstein et al. 1999). The ability to detect high frequencies may be an adaptation to shallow water, where the propagation of low frequency sound is limited (Gerstein et al. 1999).

Manatees produce vocalizations from 0.6 to 12 kHz (dominant frequency range from 2 to 5 kHz), and last 0.18 to 0.9 sec (Richardson et al. 1995; Niezrecki et al. 2003; O’Shea and Pøche

2006). Recently, vocalizations below 100 Hz have also been recorded (Frisch and Frisch 2003). Average source levels for vocalizations range from 90 to 138 dB re 1 μPa (average: 100 to 112 dB) (Nowacek et al. 2003; Phillips et al. 2004).

Sea Turtle Hearing

Little is known about sea turtle sound production and hearing or the dependency of turtles on sound for survival (Croll et al. 1999; Bartol and Ketten 2006). The majority of studies have looked at green (Ridgway et al. 1969) and loggerhead sea turtles (Bartol et al. 1999). More recently, auditory brainstem response hearing studies have been conducted on captive juvenile and subadult green and juvenile Kemp's ridley sea turtles (Bartol and Ketten 2006). These studies generally indicate that at least some species are capable of hearing low-frequency sounds (Ridgway et al. 1969; Lenhardt et al. 1983; Bartol et al. 1999), and that sensitivity appears to vary with age (Bartol and Ketten 2006). The range of maximal sensitivity for sea turtles is 100–800 Hz with an upper limit of about 1,000 Hz. Hearing below 80 Hz is apparently less sensitive but still potentially of use (Lenhardt 1994). Green turtles are most sensitive between 200 and 700 Hz, with peak sensitivity at 300–400 Hz with slight variation for juveniles and subadults, the latter based on a few individuals (Ridgway et al. 1969; Bartol and Ketten 2006). The overall range of green sea turtle hearing is reported at 60–1,000 Hz (Ridgway et al. 1969). Juvenile loggerheads were reported to have a hearing range of 250–1,000 Hz (Bartol et al. 1999). Loggerheads avoid sources of low-frequency sound in the 25–1,000 Hz range (O'Hara and Wilcox 1990). Two juvenile Kemp's ridley turtles generally had a lower upper range and lower range of sensitivity compared to what is known for green and loggerhead sea turtles. Sounds emitted by female leatherback turtles when nesting were in the 300–500 Hz range (Mrosovksy 1972).

Bartol et al. (1999) tested the hearing of juvenile loggerhead sea turtles. Those authors used a standard electrophysiological method (auditory brainstem response, ABR) to determine the response of the sea turtle ear to two types of vibrational stimuli: (1) brief, low-frequency broadband clicks, and (2) brief tone bursts at four frequencies from 250 to 1000 Hz. They demonstrated that loggerhead sea turtles hear well between 250 and 1000 Hz; within this frequency range, the turtles were most sensitive at 250 Hz. These authors did not measure hearing sensitivity below 250 Hz or above 1000 Hz. There was an extreme decrease in response to stimuli above 1000 Hz and the vibrational intensities required to elicit a response may have damaged the turtle's ear. The signals used in this study were very brief — 0.6 ms for the clicks, and 0.8 to 5.5 ms for the tone bursts. In other animals, auditory thresholds decrease with increasing signal duration up to about 100 – 200 ms. Thus, sea turtles probably could hear weaker signals than demonstrated in this study if the signal duration were longer.

Moein et al. (1994) used a related evoked potential method to test the hearing of loggerhead sea turtles exposed to a few hundred pulses from a single airgun. Turtle hearing was tested before, within 24 h after, and two weeks after exposure to pulses of airgun sound. Levels of airgun sound to which the turtles were exposed were not specifically reported. The authors concluded that five turtles (of ~11 tested?) exhibited some change in their hearing when tested within 24 h after exposure relative to pre-exposure hearing, and that hearing had reverted to normal when tested two weeks after exposure. These results are consistent with the occurrence of Temporary Threshold Shift (TTS), i.e. temporary hearing impairment, upon exposure of the turtles to airgun pulses. Unfortunately, the report does not state the size of the airgun used, or the received sound levels at various distances. The distances of the turtles from the airgun were also variable during the tests; the turtle was about 30 m from the airgun at the start of each trial, but it could then either approach the airgun or move away to a maximum of about 65 m during subsequent airgun pulses. Thus, the levels of airgun sounds that apparently elicited TTS are not known. Nonetheless, it is noteworthy that there was evidence of TTS from exposure to pulses from a single airgun. However, it may be relevant that these turtles were confined and unable to move more than about 65 m away. Turtles in the open sea might move away, resulting in less exposure than occurred during this experiment.

In summary, the limited available data indicate that the frequency range of best hearing sensitivity by sea turtles extends from roughly 250-300 Hz to 500-700 Hz. Sensitivity deteriorates at lower and higher frequencies. However, there is some sensitivity to frequencies as low as 60 Hz, and probably as low as 30 Hz. Thus, there is substantial overlap in the frequencies that sea turtles detect vs. the frequencies of many industrial noises. We are not aware of measurements of the absolute hearing thresholds of any sea turtle to waterborne sounds. In the absence of relevant absolute threshold data, it is not possible to estimate how far away an anthropogenic noise source might be audible.

Types of Noise Associated with the Port Dolphin Project

Underwater sounds produced during the construction and operation of the Port Dolphin LNG deepwater port can be classified into three broad categories. Sounds of short duration that are produced intermittently or at regular intervals, such as sounds from pile driving, are classified as "pulsed." Sounds produced for extended periods, such as sounds from generators, are classified as "continuous." Sounds from moving sources, such as ships, can be continuous, but for an animal at a given location, these sounds are "transient" (i.e., increasing in level as the ship approaches and then diminishing as it moves away). Studies indicate that marine animals respond somewhat differently to the three categories of noise. In general, baleen whales tend to react to lower received levels of continuous sound than of pulsed sound. Masking effects are expected to be less severe when sounds are pulsed or transient than when they are continuous. Because little information is available on the effects on marine mammals and sea turtles of the specific noise sources likely to be produced at the Port Dolphin site, marine animal reactions to the three broad categories of noise produced by other industrial activities are reviewed below.

Continuous Sounds

Dolphins and other toothed whales may show considerable tolerance of floating and bottom-founded drillrigs and their support vessels. Kapel (1979) reported many pilot whales (*Globicephala melas*) within visual range of drillships and their support vessels off West Greenland. Beluga whales (*Delphinapterus leucas*) have been observed swimming within 100-

150 m of an artificial island while drilling was underway (Fraker and Fraker 1979, 1981), and within 1,600 m of the drillship *Explorer I* while the vessel was drilling (Fraker and Fraker 1981). Some belugas in Bristol Bay and the Beaufort Sea, Alaska, when exposed to playbacks of drilling sounds, altered course to swim around the source, increased swimming speed, or reversed direction of travel (Stewart et al. 1982; Richardson et al. 1995). Reactions of beluga whales to semi-submersible drillship noise were less pronounced than were reactions to motorboats with outboard engines. Captive belugas exposed to playbacks of recorded semi-submersible noise seemed quite tolerant of that sound (Thomas et al. 1990).

Harbor porpoises (*Phocoena phocoena*) off Vancouver Island, British Columbia, were found to be sensitive to the simulated sound of a 2-MW offshore wind turbine (Koschinski et al. 2003). The porpoises remained significantly further away from the sound source when it was active, and this effect was seen out to a distance of 60 m. The device used in that study produced sounds in the frequency range of 30–800 Hz, with peak source levels of 128 dB re 1 μPa at 1 m at the 80 and 160 Hz frequencies.

TTSs were measured in a single captive bottlenose dolphin (*Tursiops truncatus*) after exposure to a continuous tone with maximum sound pressure levels at frequencies ranging from 4–11 kHz that was gradually increased in intensity to 179 dB re 1 μPa and in duration to 55 minutes (Nachtigall et al. 2003). No threshold shifts were measured at sound pressure levels of 165 or 171 dB re 1 μPa. However, at 179 dB re 1 μPa, TTSs >10 dB were measured during different trials with exposures ranging from 47-54 minutes. Hearing sensitivity was apparently recovered within 45 minutes after noise exposure.

<u>Transient Sounds</u>

<u>Vessels</u>

Broadband source levels (at 1 m) for most small ships where marine mammal reactions have been measured are in the 170-180 dB re 1 μPa range, excluding infrasonic components (Richardson et al. 1995). Broadband underwater sounds from the offshore supply ship *Robert Lemeur* in the Beaufort Sea were 130 dB at a distance of 0.56 km (Greene 1987), and were 11 dB higher when bow thrusters were operating than when they were not (Greene 1985, 1987). The *Robert Lemeur* had nozzles around the thruster propellers. Broadband noise levels from ships lacking nozzles or cowlings around the propellers can be about 10 dB higher than those from ships with the nozzles (Greene 1987).

Some species of small toothed cetaceans avoid boats when they are approached to within 0.5-1.5 km, with occasional reports of avoidance at greater distances (Richardson et al. 1995). Some toothed whale species appear to be more responsive than others. Beaked whales and beluga whales seem especially responsive to boats.

Dolphins may tolerate boats of all sizes, often approaching and riding the bow and stern waves (Shane et al. 1986). At other times, dolphin species that are known to be attracted to boats will avoid them. Such avoidance is often linked to previous boat-based harassment of the animals (Richardson et al. 1995). Coastal bottlenose dolphins that are the object of whale-watching activities have been observed to swim erratically (Acevedo 1991), remain submerged for longer periods of time (Janik and Thompson 1996; Nowacek et al. 2001), display less cohesiveness among group members (Cope et al. 1999), whistle more frequently (Scarpaci et al. 2000), and rest less often (Constantine et al. 2004) when boats were nearby. Pantropical spotted dolphins (*Stenella attenuata*) and spinner dolphins (*S. longirostris*) in the eastern Tropical Pacific, where they have been targeted by the tuna fishing industry because of their association with these fish, show avoidance of survey vessels up to six nautical miles away (Au and Perryman 1982; Hewitt 1985), whereas spinner dolphins in the Gulf of Mexico were observed bowriding the survey vessel in all 14 sightings of this species during one survey (Würsig et al. 1998).

Harbor porpoises tend to avoid boats. In the Bay of Fundy, Polacheck and Thorpe (1990) found harbor porpoises to be more likely to be swimming away from the transect line of their survey vessel than swimming toward it and more likely to be heading away from the vessel when they were within 400 m of it. Similarly, off the west coast of North America, Barlow (1988) observed harbor porpoises avoiding a survey vessel by moving rapidly out of its path within 1 km of that vessel.

Bottlenose dolphins along the inshore waters of the Florida coast are exposed to very high levels of underwater noise and disturbance. For example, the 120 resident bottlenose dolphins in Sarasota Bay share the inshore waters with over 34,000 registered boats (Nowacek et al. 2001). This population is exposed to a close approach (within 100 m) by a boat approximately every 6 minutes on average. Presumably, the situation is similar in the Tampa Bay area.

Beluga whales are generally quite responsive to vessels. Belugas in Lancaster Sound in the Canadian Arctic showed dramatic reactions in response to icebreaking ships, with received levels of sound ranging from 101 dB to 136 dB re 1 μPa in the 20–1,000-Hz band at a depth of 20 m (Finley et al. 1990). Responses included emitting distinctive pulsive calls that were suggestive of excitement or alarm and rapid movement in what seemed to be a flight response. Reactions occurred out to 80 km from the ship. Although belugas in the St. Lawrence River occasionally show positive reactions to ecotourism boats by approaching and investigating those boats, one study found the belugas to surface less frequently, swim faster, and group together in the presence of boats (Blane and Jaakson 1994). Another study found belugas to use higher-frequency calls, a greater redundancy in their calls (more calls emitted in a series), and a lower calling rate in the presence of vessels (Lesage et al. 1999). The level of response of belugas to vessels is partly a function of habituation. The distant fleeing responses in the High Arctic do not occur in the Beaufort Sea and the Gulf of St. Lawrence where ship traffic is much more frequent and regular.

Most beaked whales tend to avoid approaching vessels (e.g., Würsig et al. 1998). They may also dive for an extended period when approached by a vessel (e.g., Kasuya 1986). Northern bottlenose whales (*Hyperoodon ampullatus*), on the other hand, are sometimes quite tolerant of slow-moving vessels (Reeves et al. 1993; Hooker et al. 2001).

Sperm whales generally show no overt reactions to vessels unless they are approached to within several hundred meters (Watkins and Schevill 1975; Würsig et al. 1998; Magalhães et al. 2002). Observed reactions include spending more (Richter et al. 2003) or less (Watkins and Schevill 1975) time at the surface, increasing swimming speed or changing heading (Papastavrou et al. 1989; Richter et al. 2003), and diving abruptly (Würsig et al. 1998).

Pulsed Sounds

The noise generated by the Port Dolphin project will mostly be continuous sources. However, there may be pile-driving used to set the anchors for the two DWPs and for other tasks. Pile-driving produces pulsive noise and therefore, a discussion of the known effects of pulsive noise is included here. Most research has been on the effects of the airgun pulses used of offshore oil and gas exploration.

Masking Effects

Masking effects of pulsed noise on marine mammal calls and other natural sounds are believed to be negligible given the discontinuous nature of these sounds. Some whales are known to continue calling in the presence of seismic pulses—their calls can be heard between the pulses (e.g., Richardson et al. 1986; McDonald et al. 1995; Greene and McLennan 2000). Although there was one report that sperm whales ceased calling when exposed to pulses from a very distant seismic ship (Bowles et al. 1994), more recent studies have reported that sperm whales continued calling in the presence of seismic pulses (Madsen et al. 2002; Jochens and Biggs 2003).

Disturbance Effects

Observed behavioral reactions of baleen whales to pulsed sounds vary depending on the sound source level, type of whale exposed to the sounds, and the whales' activity when the sounds were heard. Most baleen whales exhibit some displacement from strong pulsed sounds. In most cases, the displacement is temporary and/or of limited extent. Experimental results (e.g., Würsig et al. 2000; Akamatsu et al. 1993) show that responses to impulsive noise sources are also highly variable among toothed whales. Under some circumstances, some species will avoid such noises when received levels exceed 180 dB. The variability is presumably related to the fact that the observations and experiments on toothed whales involved a variety of species in a variety of situations, and involved sources that emitted sounds at widely varying source levels and at differing frequencies, pulse lengths, and inter-pulse intervals.

Data on short-term reactions (or lack of reactions) of cetaceans to impulsive noises do not necessarily provide information about long-term effects. It is not known whether impulsive noises affect reproductive rate or distribution and habitat use in subsequent days or years. Gray whales continue to migrate annually along the west coast of North America despite intermittent seismic exploration (and much ship traffic and an existing developed oil field) in that area for decades (Malme et al. 1984). Bowhead whales continue to travel to the eastern Beaufort Sea each summer despite previous long-term seismic exploration in their summer and autumn range.

Bowheads are often seen in summering areas where seismic exploration occurred in preceding summers (Richardson et al. 1987). They also have been observed over periods of days or weeks in areas repeatedly ensonified by seismic pulses. However, it is not known whether the same individual bowheads were involved in these repeated observations (within and between years) in strongly ensonified areas. It is also not known whether whales that tolerate exposure to seismic pulses are stressed.

Hearing Impairment

Temporary hearing loss in toothed whales exposed to pulsed sounds has been reported. Ridgway et al. (1997) and Schlundt et al. (2000) exposed bottlenose dolphins and beluga whales to single 1-s pulses of underwater sound. TTSs generally became evident at received levels of 192-201 dB re 1 µPa rms at 3, 10, 20, and 75 kHz. At 75 kHz, one dolphin exhibited a TTS at 182 dB, and at 0.4 kHz, no dolphin or beluga exhibited a TTS after exposure to levels up to 193 dB (Schlundt et al. 2000). There was no evidence of permanent hearing loss, as all hearing thresholds returned to baseline values at the end of the study.

Finneran et al. (2002) exposed a beluga whale and a bottlenose dolphin to single pulses using an 80-in^3 water gun. Masked TTS (MTTS), defined as a TTS that occurred with considerable background noise, was observed in a beluga after exposure to a single impulse with a peak-to-peak pressure of 226 dB re 1 µPa, peak pressure of 160 kPa, and total energy flux of 186 dB re 1 µPa2·s. Thresholds returned to within 2 dB of the pre-exposure value approximately four minutes after exposure. No MTTS was observed in a bottlenose dolphin exposed to one pulse with a peak-to-peak pressure of 228 dB re 1 µPa, equivalent to a peak pressure of 207 kPa and total energy flux of 188 dB re 1 µPa2·s (Finneran et al. 2000, 2002). In that study, TTS was defined as occurring when the post-exposure threshold was ≥6 dB higher than the pre-exposure threshold. Pulse duration at the highest exposure levels, where MTTS became evident in the beluga, was typically 10-13 ms.

Non-Auditory Physiological Effects

Very little is known about the potential for impulsive sounds to cause non-auditory physiological effects in marine mammals. Available data suggest that such effects, if they occur at all, would be limited to short distances from the very loud noise sources. However, the available data do not allow for meaningful quantitative predictions of the numbers (if any) of marine mammals that might be affected in these ways. Marine mammals that show behavioral avoidance of pulsed sounds, including most baleen whales, some odontocetes, and some pinnipeds, are unlikely to incur auditory impairment or other physical effects.

Romano et al. (2004) exposed a beluga whale and a bottlenose dolphin to single underwater impulsive sounds (up to 200 kPa) from a seismic water gun and measured nervous system and immune system indicators before and after these exposures. In the beluga whale, levels of norepinephrine, epinephrine, and dopamine increased significantly with increasing sound levels and were significantly greater after sound exposures >100 kPa than after sound exposures <100 kPa and after control exposures. In the bottlenose dolphin, there was a significant increase in aldosterone level and a significant decrease in monocyte count after exposure to impulsive sounds. How short-term stress responses might affect the long-term health of cetaceans is unknown.

Seismic Surveys

Little systematic information is available on the reactions of toothed whales to seismic pulses. Their reactions to seismic surveying are variable and not well characterized. Dolphins and porpoises are often seen by observers on active seismic vessels, occasionally at close distances (e.g., bow riding). However, some studies, especially near the UK, showed localized (~1 km) avoidance. Recent studies show little evidence of reactions by sperm whales to airgun pulses, contrary to earlier indications. There are no specific data on responses of beaked whales to seismic surveys. There is increasing evidence that some beaked whales may strand after exposure to strong noise from mid-frequency sonars. Whether they ever do so in response to low frequency seismic survey noise is unknown.

Seismic operators sometimes see species of toothed whales near operating airgun arrays (e.g., Duncan 1985; Arnold 1996; Stone 2003). When a 3,959-in^3, 18-gun array was firing off California, toothed whales behaved in a manner similar to that observed when the airguns were silent (Arnold 1996). Most, but not all, dolphins often seemed to be attracted to the seismic vessel and floats, and some rode the bow wave of the seismic vessel, seemingly unperturbed by firing guns. However, in Puget Sound, Dall's porpoises observed when a 6,000-in^3, 12-16 gun array was firing, tended to be heading away from the boat (Calambokidis and Osmek 1998). White-beaked (*Lagenorhynchus albirostris*) and white-sided dolphins (*L. acutus*) in the U.K. showed fewer positive interactions (approaching, bow riding, swimming alongside) with a seismic vessel while its airgun array was operating. These species, along with killer whales, harbor porpoises, and bottlenose dolphins all were seen further away from the seismic vessel when its airguns were firing than when they were not (Stone 2003).

Goold (1996a,b,c) studied the effects of 2D seismic surveys in the Irish Sea on common dolphins (*Delphinus delphis*). Passive acoustic surveys were conducted from the "guard ship" that towed a hydrophone 180 m aft. The results indicated that there was a local displacement of dolphins around the seismic operation. However, observations indicated that the animals were tolerant of the sounds at distances outside a 1-km radius from the guns (Goold 1996a). Initial reports of larger-scale displacement were later shown to represent a normal autumn migration of dolphins through the area, and were not attributable to seismic surveys (Goold 1996a,b,c).

There are some limited observations suggesting that sperm whales in the Southern Ocean ceased calling during some (but not all) times when exposed to weak noise pulses from extremely distant (>300 km) seismic exploration (Bowles et al. 1994). This "quieting" was suspected to represent a disturbance effect. Sperm whales exposed to pulsed man-made sounds at higher frequencies often cease calling (Watkins and Schevill 1975; Watkins et al. 1985).

On the other hand, recent (and more extensive) data from vessel-based monitoring programs in UK waters suggest that sperm whales in that area show little evidence of avoidance or behavioral disruption in the presence of operating seismic vessels (Stone 2003). These types of observations are difficult to interpret because the observers are stationed on or near the seismic vessel, and may underestimate reactions by some of the more responsive species or individuals, which may be beyond visual range. A recent study off northern Norway indicated that sperm whales continued to call when exposed to pulses from a distant seismic vessel, with received levels of up to 146 dB re 1 µPa peak-peak, and remained in the area throughout the survey (Madsen et al., 2002). Similarly, sperm whales in the Gulf of Mexico did not alter their calling behavior in the presence of seismic pulses, and there was no indication that they moved away from the sound source at received levels of up to 148 dB (Jochens and Biggs 2003). A study conducted off Nova Scotia detected no difference in the acoustic abundance of male sperm whales between years without any seismic survey activity and years with an active seismic program, with received levels of 130 to 150 dB re 1 µPa (McCall Howard 1999). In addition, in the Gulf of Mexico, Davis et al. (2000) found no differences in sighting frequencies of sperm whales among areas with and without seismic surveys, with received levels of up to >12 dB above ambient noise levels.

(3) NOISE SOURCES OF THE PORT DOLPHIN PROJECT AND PROPAGATION MODELING OF UNDERWATER NOISE

Acousticians from JASCO Research have modeled the varioue noise sources associated with the Port Dolphin project (Gaboury et al. 2008). That report evaluates sound propagation to determine the amounts of noise that marine animals will be exposed to. The data in Gaboury et al. (2008) underlie the predictions of project effects that are made in the Section 4.

(4) PREDICTED EFFECTS OF UNDERWATER NOISE FROM THE PORT DOLPHIN PROJECT ON MARINE MAMMALS AND SEA TURTLES

In this section, we integrate the information from previous sections to predict the biological effects of the underwater noise associated with the proposed Port Dolphin Project. Data on the species and numbers of marine animals in the project area are summarized in Chapter 4 of Volume II. Information on the known effects of the types of noise associated with the Port Dolphin Project is summarized in Section 2 based on the results of other studies. The source levels and modeled propagation characteristics of underwater noise from the Port Dolphin Project are presented in Section 3. Here, in Section 4, we determine the number of animals that might be affected by the proposed project based on the modeled sound fields from the project activities.

Potentially-affected Marine Animals

The principal groups of marine animals addressed in this assessment are marine mammals (toothed whales and manatees) and sea turtles. The two groups are discussed separately below.

Marine Mammals

Seven species of baleen whales occur in the Gulf of Mexico but they occupy waters that are off the shelf and beyond the range of any significant noise from the Port Dolphin project.

The only noise that they will be exposed to will be from for the ocean passage of the SRVs. At sea, the SRVs will be like any other large ship and will have similar effects. Since offshore shipping is routine, baleen whales are not discussed further.

Twenty-one species of odonocete were identified in the Gulf of Mexico were identified in Chapter 4, Volume II. Of these, only the bottlenose dolphin and Atlantic spotted dolphin are regular in the Port Dolphin project area. The following analyses are restricted to these two species and to the Florida manatee, which is the only manatee in the area.

Pulsive Sounds

National Marine Fisheries Service (NMFS 2000) has developed criteria for allowable levels of noise to which whales can be exposed without potentially affecting them. For pulsive sounds, NMFS requires that individual whales not be exposed to received levels of over 180 dB re 1 µPa (rms) to protect the animals from potentially damaging noise levels. Received levels of over 160 dB may cause disturbance or "Level B" harassment. Level B harassment is defined by the Marine Mammal Protection Act as "… *disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering.*" Corresponding criteria for Florida manatees have not been determined. To be conservative, the cetacean criteria are used for the manatee in the present document.

Pulsive sounds from the Port Dolphin Project will occur from pile-driving used to fix the anchors of each of the two DWPs and at points along the pipeline route. Based on the acoustic modeling in Gaboury et al. (2008), it is predicted that the M-weighted 180 dB contour for bottlenose and Atlantic spotted dolphins will occur at about 100 m from the source of the pile-driving noise in offshore waters and at 200 m in inshore waters. Given the general vessel activity that will occur in conjunction with the pile-driving, it is safe to conclude that the dolphins will approach close enough to be exposed to 180 dB levels. The M-weighted 160 dB "disturbance criterion" for the pile-driving pulses would extend to 3.1 km in offshore waters and 1.7 km in inshore waters for bottlenose dolphin, Atlantic spotted dolphin, and manatee. Assuming circular sound fields, the areas ensonified to over 160 dB would be about 30.2 km² in offshore waters and 9.1 km² in inshore waters. Using the density estimates in Table 4-13 in Volume II, it is estimated that, depending upon the season, 0.7 to 2.2 groups of bottlenose dolphins could be expected per 100 km² of habitat or 0.2 to 0.7 groups per 30.2 km². The average size of bottlenose dolphin groups in the Eastern Gulf of Mexico was 12.3. Therefore, it is predicted that 2 to 9 bottlenose dolphins could be temporarily disturbed in offshore waters. By similar logic, the number of groups per 9.1 km² that might be disturbed in inshore waters ranges from 0.06 to 0.2. At 12.3 animals per group, it is predicted that 1 to 3 bottlenose dolphins could be temporarily disturbed.

Using a similar approach for Atlantic spotted dolphins provides estimates of 1 to 4 animals that might be disturbed by exposure to received levels of 160 dB or more in offshore waters and 0.2 to 1 in inshore waters (based on density data in Table 4-13, Volume II). Clearly, the project pile-driving will have very little effect on dolphin populations in the Tampa Bay area.

Gaboury et al. (2008) considered manatees to be closest to pinnipeds for consideration of the M-weighting. However, the zone of best hearing in manatees is in the 6-20 kHz range (Gerstein et al. 1999), which would indicate that the manatee might best be considered a 'mid-frequency' species. The manatee is a shallow-water coastal species that would not be exposed to the mostly low frequency noise generated by project activities offshore. In inshore waters, the manatees will not occur within the 200 m radius of the 180 dB contour from the pile-driving. The 160 dB radius in inshore waters is 1.7 km but it is unlikely that much of that noise (mostly low frequency with long wave lengths) would propagate into the shallow waters occupied by manatees. Therefore, it is concluded that this phase of the project would no effect on manatees in the Tampa Bay area.

Transient Continuous Sounds

Two types of transient sounds will occur: the slow-moving pipe-laying dredging operation and faster regular passages by the LNG carriers (SRVs) as they arrive at and leave the DWPs. The pipe-laying operation will occur once during a 4-5 month period. The passages by the SRVs will occur every 4-8 days during the life of the project.

The responses of marine animals to continuous underwater sounds are poorly known and highly variable within and among species depending upon many circumstances. NMFS has used a criterion of 120 dB as the level at which whales may be disturbed by continuous underwater noise. This criterion has been adopted in the present analysis.

Buoy Installation--Gaboury et al. (2008) modelled the sound levels associated with installation of the DWP buoys in the offshore waters. The arbitrary criterion for disturbance of 120 dB for the three mid-frequency species considered here has a radius of 2.9 km. Assuming a circular sound field offshore, the area ensonified with sounds of 120 dB or more would be about 26.4 km². Based on the Department of the Navy study cited in Table 4-13 in Volume II, there were 0.1 to 0.4 groups of Atlantic spotted dolphins per 100 km² of nearshore habitat in the Eastern Gulf of Mexico. With an average group size of 26.5, there could be between 1 and 3 spotted dolphins that could be disturbed by the installation of the offshore buoys. Similar analyses for bottlenose dolphins suggests that, depending on season, between 2 and 7 bottlenose dolphins could be disturbed by the installation of the buoys.

The DWP buoys are far enough offshore that there will be no disturbing noise reaching manatees in shallow coastal waters.

Pipe-laying Operations—Pipe-laying operations are expected to occur over 4-5 month period. Propagation of the underwater noise generated by the operation will be variable depending on the water depth at the source. Gaboury et al. (2008) modeled three scenarios: offshore, Passage Key, and Tampa Bay.

For the mid-frequency species in the **offshore**, the 120 dB re 1 µPa disturbance criterion will have a radius of 6.8 km and encompass an area of about 145 km², assuming a circular affected area. The densities of Atlantic spotted dolphins and bottlenose dolphins in the nearshore Eastern Gulf of Mexico were 0.1 to 0.4 groups (2.2 to 10.7 individuals) per 100 km² and 0.7 to 2.2 groups (8.2 to 26.7 individuals) per 100 km², respectively (Table 4-13, Volume II). Therefore, the numbers of Atlantic spotted dolphins subjected to the 120 dB criterion area of 145 km² could range from 3 to 16. The corresponding numbers of bottlenose dolphins that could be affected are 12 to 39.

Pods of odontocetes are often fast-moving and may not stay in the small areas discussed here for very long. Therefore, different pods may be exposed to the noise during the 4-5 month construction period but each pod is likely to be exposed for only a short period. There are no data on turnover rates but the overall number of whale days of exposure might be well represented by the numbers calculated here.

The potentially disturbing noise (120 dB and over) from the offshore buoy installation will have no effect on the coastal manatees because the received sounds will be well below the 120 dB level.

The very shallow water (~5 m) in **Passage Key** prevents propagation of most of the low frequency sounds. The M-weighted 120 dB zone is expected to extend only 1.5 km from the source in Passage Key. Animals in Passage Key are likely to be disturbed by the presence of the vessels as much as by the noise itself. The small size of the affected area means that very few dolphins and manatees would be disturbed,

In **Tampa Bay**, sounds from the pipe-laying operation would propagate better than in Passage Key. The M-weighted 120 dB zone is expected to extend 5.9 km for the mid-frequency species of interest here (Gaboury et al. 2008). This would equate to an ensonified area of ~109 km², if the area was circular. However, given the confines of Tampa Bay and the presence of coasts and shallow water, the ensonified area would be less than the nominal 109 km². The Atlantic spotted dolphin is found primarily on the continental shelf and is not likely to occur in Tampa Bay whereas the bottlenose dolphin occurs in Tampa Bay more regularly. If the continental shelf density applies in Tampa Bay, then about 9-27 individuals could be disturbed, depending upon the season during which the activity will occur.

Pipeline Burial/Covering—The process of burying the pipeline is expected to take 4-5 months. Gaboury et al. (2008) modelled the underwater noise associated with this operation in offshore and inshore (Tampa Bay) locations. At the offshore location, the M-weighted 120 dB zone is expected to extend 7.9 km for the mid-frequency dolphins of interest here. This equates to an ensonified area of ~196 km², assuming the area was circular. Depending on the season, the predicted numbers of bottlenose dolphins that would be present, and potentially disturbed, in the ensonified area would range from 16 to 52. Similarly, the numbers of Atlantic spotted dolphins that are disturbed would range from 4 to 21. Along most of the offshore pipeline route, noise from the pipeline burial operation would not reach into the shallow waters occupied by manatees. There may be a small number of occasions when there is some very minor disturbance to manatees but these would be rare.

In the inshore waters of Tampa Bay, the M-weighted underwater noise level of 120 dB is expected to extend to 6.6 km covering an area of ~137 km², assuming a circular area. However, given the confines of Tampa Bay and the presence of coasts and shallow water, the ensonified area would be less than 137 km². The Atlantic spotted dolphin is found primarily on the continental shelf and is not likely to occur in Tampa Bay whereas the bottlenose dolphin occurs in Tampa Bay more regularly. If the continental shelf density applies in Tampa Bay, then about 11-37 bottlenose dolphins could be disturbed, depending upon the season during which the activity occurs. There is some potential for a small amount of underwater noise to propagate into coastal waters occupied by manatees. However, this cannot be quantified without very site-specific data on the locations of manatees and the bottom topography of these occupied areas.

LNG Carrier Transits— Gaboury et al. (2008) modelled three scenarios involving the SRVs. They included cruise speed of 36 km/h (19.5 knots); approach speed of <18 km/h (10 knots); and docking at the DWP (dead slow with 2 bow thrusters and 1-2 stern thrusters operating). The crusie and docking scenarios were quite similar but the approach scenario produced less underwater noise. The unweighted 120 dB radius were 3.9 km for cruise speed, 1.7 km for approach speed, and 3.6 km for docking. When M-weighting for mid-frequency species was applied, the respective distances were 1.7 km, 0.5 km and 1.7 km. Taking the highest levels of 3.9 km and 1.7 km, the effective ensonified area would be 47.8 km² or 9.1 km². In either case the number of dolphins potentially disturbed would be small. Using the unweighted case, the total number of dolphins (both species) in the 47.8 km² disturbed area would range from 5 to 18 individuals (calculated from Table 4-13, Volume II). When the M-weighting is considered, the number of dolphins in the disturbed area would range from 1 to 3 animals.

A SRV would arrive at one DWP and another carrier would depart from the other DWP every 4-8 days. Thus, the amount of time that any individual dolphin is likely to be exposed to disturbing noise is very small and probably inconsequential, particularly since most marine mammals habituate to regularly occurring, non-threatening ship passages. However, given that voyages occur year-round it might be appropriate to sum the average number of animals in each quarter to arrive at a more realistic total of animals that might be disturbed. Summing the average number of dolphins for the four quarters yields a total of 94.2 dolphins or 45 per 47.8 km² that might be disturbed over the course of a year.

Again, it is clear that offshore underwater noise associated with the SRVs will not propagate into the coastal waters occupied by manatees and there will be no effects on that species.

Fixed-Location Continuous Sounds

Two types of underwater noise will occur regularly at the fixed locations of the two DWPs. The first is the sounds from the thrusters on each carrier that will be used to position the carrier over the DWP buoy. This operation was discussed earlier. The second type is the noise that will emanate from the SRV while it is fixed to the DWP. These noises are associated with the re-gasification process and with maintaining ship functions while moored with the main engines turned-off. The noise levels of the re-gasification process are quite low and barely reach 110 dB in the water near the vessel. There are no situations where the noise level exceeds 120 dB even a few meters from the vessel. Therefore, there will be no effects on marine animals (LGL and JASCO Research 2005).

Sea Turtles

Five species of sea turtle occur in the Eastern Gulf of Mexico. The effects of underwater noise on sea turtles are not well studied. There are no safety criteria for sea turtles similar to those used by NMFS for marine mammals.

Pulsive Sounds

There is very little information available on the responses of sea turtles to pulsed sounds. The available information comes from experiments using seismic airguns. Avoidance out to 30 m was demonstrated in loggerhead turtles in a 10-m deep canal exposed to seismic airgun sounds (O'Hara and Wilcox 1990). The airguns used in that study produced a sound with its strongest components at a frequency of 25 Hz, with some frequencies up to 1 kHz. Although those authors did not report received sound pressure levels, McCauley et al. (2000), using a similar sound source, estimated that the received sound pressure levels in the O'Hara and Wilcox (1990) study would have been on the order of 175–176 dB re 1 μPa rms.

McCauley et al. (2000) observed the responses of a caged green turtle and a loggerhead turtle to the approach and retreat of an operating seismic airgun. Those animals noticeably increased their swimming activity above a source level of approximately 166 dB re 1 μPa rms. Above 175 dB re 1 μPa rms their behavior became more erratic, possibly indicating an agitated state. The turtles spent increasingly more time swimming as the airgun level increased. The point at which the turtles showed the more erratic behavior likely indicates the point at which avoidance would occur for unrestrained turtles. To be conservative, it is assumed here that 170 dB represents the threshold at which pulsive sounds elicit a disturbance response in sea turtles.

Received noise levels of 170 dB will occur up to 0.85 to 1.1 km from the inshore and offshore pile-driving operations, respectively ensonifying areas of about 2.3 to 3.8 km^2 (see Section 3). Turtle densities in the nearshore zone of the eastern Gulf of Mexico ranged from 6 to 19 per 100 km^2 depending upon the season (Table 4-15 in Volume II). It should be remembered that these are minimal density estimates that are not fully corrected for unseen animals. Nonetheless, combining the small areas ensonified with the observed densities indicates that small numbers (1 or 2) of sea turtles would be temporarily disturbed by the pulsive noise from the pile-driving.

Continuous Sounds

The only information available on sea turtle reactions to continuous sound sources comes from one study of captive loggerhead turtles. In that study, resting turtles reacted to low-frequency (20–80 Hz) continuous tones projected into their tank by swimming to the surface and remaining there (Lenhardt 1994). These "startle responses" were elicited using sound vibrations in the tank. There are no data on the disturbance responses of free-swimming, wild sea turtles. Sea turtles are low-frequency hearing specialists similar to baleen whales, which have disturbance criteria for pulsive sounds of 160 dB and continuous sounds of 120 dB or a difference of 40 dB. Based on very limited data, it appears that pulsive sounds of 175 dB are necessary to disturb sea turtles. A 40 dB difference in pulsive to continuous response ratio for sea turtles would establish a received level for continuous sounds of about 135 dB to elicit disturbance responses by sea turtles. A conservative disturbance response threshold of 130 dB is used in the following analyses. There is no need to use the M-weighted values here since weighted and unweighted values are essentially the same for low-frequency hearing species such as the sea turtles.

Transient Continuous Sounds

Two types of transient sounds will occur: the slow-moving pipe-laying and burying operation and faster regular passages by the LNG carriers (SRVs) as they arrive at and leave the DWPs. The pipe-laying operation will occur once during a 4-5 month period. The passages by the SRVs will occur every 4-8 days during the life of the project.

Buoy Installation--Gaboury et al. (2008) modelled the sound levels associated with installation of the DWP buoys in the offshore waters. The criterion for disturbance of 130 dB for sea turtles has a radius of 1.4 km. Assuming a circular sound field offshore, the area ensonified with sounds of 130 dB or more would be about 6.1 km². Based on the Department of the Navy study cited in Table 4-15 in Volume II, there were 6.0 to 19.2 sea turtles per 100 km² of nearshore habitat in the Eastern Gulf of Mexico. Based on these data, there could be between 0 and 2 sea turtles that could be disturbed by the installation of the offshore buoys. Therefore, the effects will be negligible.

Pipe-laying Operations—Pipe-laying operations are expected to occur over 4-5 month period. Propagation of the underwater noise generated by the operation will be variable depending on the water depth at the source. Gaboury et al. (2008) modelled three scenarios: offshore, Passage Key, and Tampa Bay.

For sea turtles in the **offshore**, the 130 dB re 1 µPa disturbance criterion will have a radius of 3.6 km and encompass an area of about 41 km², assuming a circular ensonified area. The densities of sea turtles (all species combined) in the nearshore Eastern Gulf of Mexico ranged from 6.0 to 19.2 per 100 km² (Table 3-15, Volume II). Therefore, the numbers of sea turtles subjected to the 130 dB criterion area of 41 km² could range from 2 to 8, depending upon season. Given the length of the construction season, it is likely that there will be some movement of turtles into and out of the ensonified area so that a larger number of individuals might be temporarily disturbed. There are no data bearing on this question.

The very shallow water (~5 m) in **Passage Key** prevents propagation of most of the low frequency sounds. The 130 dB zone is expected to extend only 1 km from the source in Passage Key. Animals in Passage Key are likely to be disturbed by the presence of the vessels as much as by the noise itself. The small size of the affected area means that very few sea turtles would be disturbed, In **Tampa Bay**, sounds from the pipe-laying operation would propagate better than in Passage Key. The 130 dB zone is expected to extend 2.1 km from the source (Gaboury et al. 2008). This would equate to an ensonified area of ~13.9 km², if the area was circular. However, given the confines of Tampa Bay and the presence of coasts and shallow water, the ensonified area would not always be as much as 13.9 km². If the continental shelf density of sea turtles applies in Tampa Bay, then about 1-3 individuals could be disturbed, depending upon the season during which the activity occurs.

Pipeline Burial/Covering—The process of burying the pipeline is expected to take 4-5 months. Gaboury et al. (2008) modelled the underwater noise associated with this operation in offshore and inshore (Tampa Bay) locations. At the offshore location, the 130 dB zone is expected to extend 3.8 km from the source. This equates to an ensonified area of ~45 km², assuming the area was circular. Depending on the season, the predicted numbers of sea turtles that would be present, and potentially disturbed, in the ensonified area would range from 3 to 9.

In the inshore waters of Tampa Bay, the underwater noise level of 130 dB is expected to extend to 2.1 km covering an area of ~14 km², assuming a circular area. However, given the confines of Tampa Bay and the presence of coasts and shallow water, the ensonified area would be less than 14 km² at some locations. Again, if the continental shelf density applies in Tampa Bay, then about 1-3 sea turtles could be disturbed, depending upon the season during which the activity occurs.

For all of the pipe-laying and related activities and all three areas considered above, it is concluded, based on the small areas ensonified, the small number of turtles that might be disturbed, and the single period of activities, that the effects of noise from the pipe-laying, dredging and burying would be negligible on turtle populations and on individual turtles.

LNG Carrier Transits— Gaboury et al. (2008) modelled three scenarios involving the SRVs. They included cruise speed of 36 km/h (19.5 knots); approach speed of 19 km/h (10 knots); and docking at the DWP (dead slow with 2 bow thrusters and 1-2 stern thrusters operating). The cruise and docking scenarios actually produced similar results, whereas the approach scenario was much lower with respect to underwater noise. The unweighted 130 dB radius was 1.5 km for cruise speed, 0.4 km for approach speed, and 1.5 km for docking. Taking the highest level of 1.5 km, the effective ensonified area would be about 7 km². Therefore, depending upon the season and using the densities calculated by the Department of the Navy in Table 4-15, Volume II, the numbers of sea turtles that could be disturbed in the ensonified area would not exceed 1.

A SRV would arrive at one DWP and another carrier would depart from the other DWP every 4-8 days. Thus, the amount of time that any individual dolphin is likely to be exposed to disturbing noise is very small and probably inconsequential, particularly since most marine animals habituate to regularly occurring, non-threatening ship passages. However, given that voyages occur year-round it might be appropriate to sum the average number of animals in each quarter to arrive at a more realistic total of animals that might be disturbed. Summing the average number of turtles for the four quarters yields a total density of 45.8 per 100 km² (Table

4-15, Volume II) or about about 3 turtles that might be disturbed over the course of a year. This would be a negligible effect.

Fixed-Location Continuous Sounds

Underwater noise associated with the docking of the SRVs at the DWPs was discussed above. Underwater noise that will emanate from the SRV while it is fixed to the DWP are associated with the re-gasification process and with maintaining ship functions while moored with the main engines turned-off. The noise levels of the re-gasification process are quite low and barely reach 110 dB in the water near the vessel. There are no situations where the noise level exceeds 130 dB even a few meters from the vessel (LGL and JASCO Research 2005). Therefore, there will be no effects on sea turtles.

Summary

The previous analyses indicate that underwater noise from the Port Dolphin project will not damage any marine animals and will temporarily disturb only very small numbers of them. The dolphins, manatees and sea turtles occupying the Port Dolphin area are already exposed to much higher levels of disturbance from the large amounts of ship traffic using the Tampa Bay area and the thousands of fishing boats and recreational boats in the area. Marine animals in the region have apparently adapted to the existing levels of disturbance and the addition of the small amount of additional disturbance from the Port Dolphin project will be barely perceptible above the existing levels.

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Appendix D

Supplemental Assessment of Underwater Noise, Horizontal Directional Drilling (HDD) Goal Post Installation

432 – 1496 Lower Water Street
Halifax, Nova Scotia, Canada, B3J 1R9

Phone: +1.902.405.3336 Fax: +1.902.405.3337
Email: info@jasco.com Website: www.jasco.com

PORT DOLPHIN ENERGY LLC DEEP WATER PORT: ASSESSMENT OF UNDERWATER NOISE FROM INSTALLATION OF GOAL POSTS

Isabelle Gaboury and Scott Carr

Version 1.0, 6 May 2010

1 Introduction

Port Dolphin Energy LLC proposes to construct and operate a Liquefied Natural Gas (LNG) Deepwater Port (DWP) at a site approximately 45 km (28 mi) west of Tampa Bay, Florida. In January, 2008, JASCO Research carried out an acoustical modeling study to predict the sound fields likely to be generated by construction and operation activities associated with the Port Dolphin DWP project (Gaboury *et al.* 2008). In this follow-up report, we present the results of additional modeling carried out to predict underwater noise levels associated with installation of H-pile structures ("goal posts") as part of horizontal directional drilling (HDD) operations. Specifically, estimates are presented for drilling and vibratory driving operations involved in the installation. Modeling methodology, including a description of the scenario modeled and source characterization, is presented in Section 2. Model parameters are summarized in Section 3. Finally, the results of the modeling study are presented in Section 4.

2 Methodology

2.1 Modeling Scenario

Horizontal Directional Drilling (HDD) will be employed for installation of the Port Dolphin pipe line at three locations along the inshore portion of the route: drilling from land to water at the Port Manatee shore approach and from water to water at two crossings of the Gulfstream pipeline (Ocean Specialists 2007) (Figure 1). HDD at the two water-to-water sites involves construction of temporary support structures. Two alternatives exist for these supports:

1. "Goal posts": For each water-to-water HDD, four H-pile structures are installed. Each consists of two vertical steel pilings with a horizontal piling or cross beam. The vertical supports are installed by first drilling a pilot hole, then vibrating the supports into the sea floor to a pre-determined embedment depth.
2. Gravity based supports: Steel structures are fabricated onshore, and installed offshore with a crane barge. No drilling or vibratory driving is involved.

The current study addresses underwater noise generation associated with the first alternative, which would produce considerably higher levels of underwater noise than the second. Equipment and source levels associated with the two phases of goal post installation (drilling and vibratory driving) are discussed in the next sub-section.

Modeling was carried out at the inshore pipe lay site described by Gaboury *et al.* (2008), located at 27°35'42.70"N, 82°41'0.97"W. Bottom depth at this site is approximately 7 m. The site is located between the two HDD sites associated with crossings of the Gulfstream pipeline (Figure 1). Based on the relatively constant water depth and environmental parameters (water column sound speed and average sediment properties) over the section of pipeline connecting the two HDD sites, model results are expected to be very similar over all three locations.

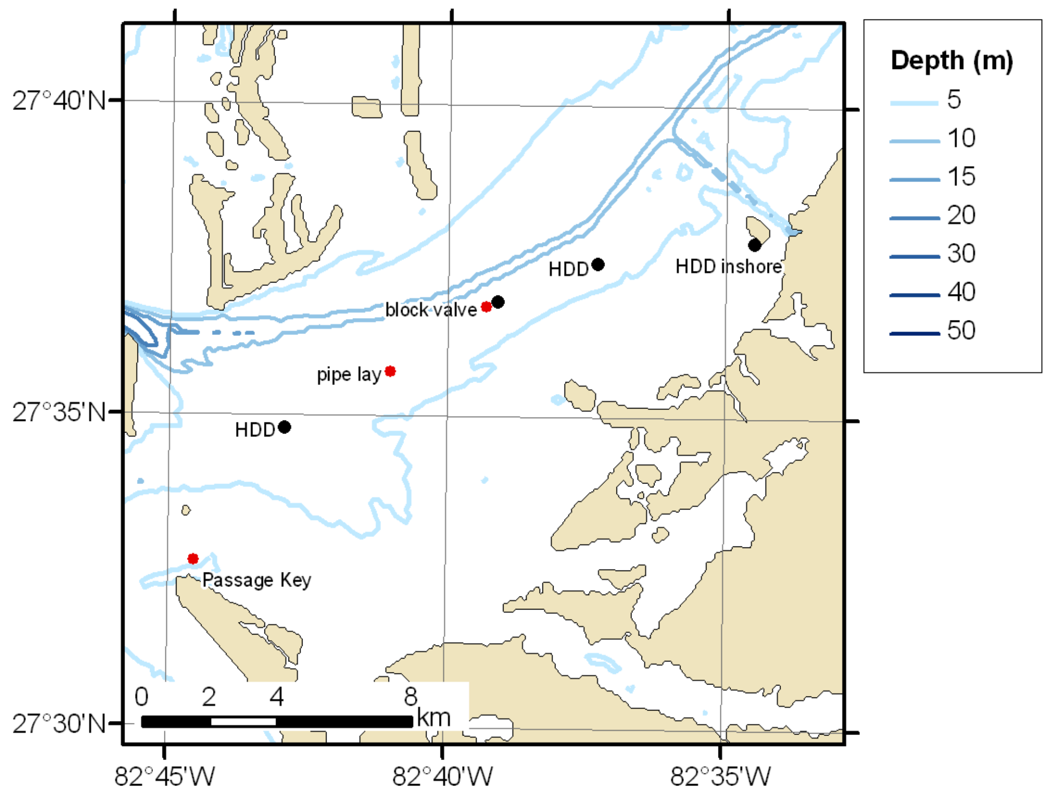

Figure 1: Overview of inshore modeling sites. Dots mark key points along the carrier route and pipeline. Red dots represent sites modeled in Gaboury *et al.* (2008).

2.2 Source Characterization

Drilling and vibratory driving will be conducted from a floating spud barge approximately 41 m in length. Drilling will involve a crane mounted drill, suspended from a crawler crane on the barge. Vibratory driving will involve a J&M model 416 vibrator, with an eccentric moment of 2535 kg-cm and frequency of 1600 vpm. The barge will also be equipped with welding equipment, an air compressor, and a generator.

Third-octave band source levels for drilling of the pilot holes are based on measurements made by Greene (1987) in the vicinity of the drillship *Explorer II* during drilling operations in the Beaufort Sea. As with drilling from a barge, these measurements include contributions from both the drill assembly itself and from equipment on the drill platform (e.g., generators). Source levels were estimated from Greene's (1987) measurements assuming cylindrical spreading (Miles *et al.* 1987); the resulting third-octave band levels are plotted in Figure 2(a) and listed in Table 1. Measurements of noise from the *Explorer II* (Greene, 1987) are only available for frequencies between 20 and 800 Hz; source levels for lower and higher frequencies within the modeled frequency range were assumed to be equal to the nearest available frequency (i.e., the source level for 10 Hz was set to that for 20 Hz, and source levels for 1000-2000 Hz were assumed to be equal to that for 800 Hz). Because the dominant source of noise is equipment located on the drilling vessel (Richardson *et al.* 1995) rather than the drilling or scraping itself, a source level of 2.2 m was used, as for other barge-mounted activities modeled by Gaboury *et al.* (2008).

Source levels for the vibratory driver were derived from measurements made by JASCO on an American Piledriving Equipment model 300 vibratory driver, with an eccentric moment of 7488 kg-cm

(Austin *et al.*, 2009) and a maximum frequency of 1500 vpm (American Piledriving Equipment, 2010); third-octave band levels are shown in Figure 2(b) and in Table 1. The vibratory driver was mounted on a moored barge during the measurements, and so noise contributions from equipment on the barge are included in the source level estimates. The APE 300 is a larger vibratory driver than the J&M 416 planned for use at Port Dolphin. However, very few measurements of underwater noise exist for pile drivers of this size, and in most cases the available reports do not describe the vibratory driver used. Additionally, scaling by vibratory driver specifications (e.g., the eccentric moment) is made difficult by the fact that pile driving source levels depend not only on the equipment but also on the piling, substrate and environment. As such, un-scaled measurements of underwater noise emanating from the APE 300 are used here as a conservative (i.e., tending to over-estimate noise levels and thus impacts) estimate of the noise likely to be generated during installation of the goal posts. As in Gaboury *et al.* (2008), the source depth for pile driving was set to half the local water depth, i.e. a source depth of 3.5 m. In actuality, sound will radiate from all portions of the pilings; this mid-water column value is a conservative estimate of the depth for an equivalent point source, as losses due to bottom and surface interactions will be less for a source at mid-depth than for one near the sea floor or surface.

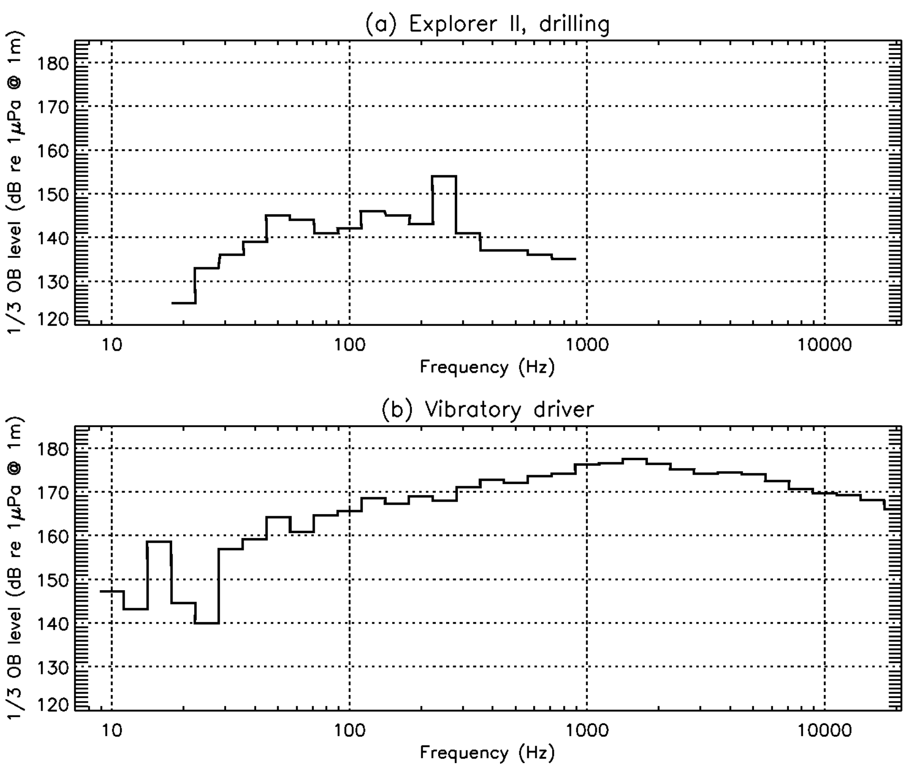

Figure 2: Third-octave band source levels for goalpost installation modeling scenarios. Source depths are 2.2 m and 3.5 m for drilling and vibratory driving, respectively. Broad-band source levels are (a) 156.7 dB re 1 μPa and (b) 186.9 dB re 1 μPa.

Table 1: Third-octave band source levels for goalpost installation scenarios, for the range of frequencies modeled (10-2000 Hz for drilling, 10-5000 Hz for vibratory driving). Source depths are 2.2 m and 3.5 m for drilling and vibratory driving, respectively.

Frequency (Hz)	**Source level (dB re 1 μPa @ 1 m)**	
	Drilling	**Vibratory driving**
10	125.0	147.3
12.5	125.0	143.1
16	125.0	158.6
20	125.0	144.6
25	133.0	139.9
31.5	136.0	156.9
40	139.0	159.2
50	145.0	164.2
63	144.0	160.9
80	141.0	164.6
100	142.0	165.6
125	146.0	168.6
160	145.0	167.3
200	143.0	168.9
250	154.0	168.0
315	141.0	171.1
400	137.0	172.8
500	137.0	172.0
630	136.0	173.6
800	135.0	174.1
1000	135.0	176.3
1250	135.0	176.6
1600	135.0	177.5
2000	135.0	176.4
2500	------	175.1
3150	------	174.1
4000	------	174.5
5000	------	174.0
Broadband	**156.9**	**186.4**

3 MONM Parameters

The model parameters used in this study were identical to those outlined in Gaboury *et al.* (2008) for the inshore pipe lay site. These are summarized below:

- Source and receiver locations: Source location was 27°35'42.70"N, 82°41'0.97"W; bottom depth at this site is 7 m. Modeled receiver depths were 2 m, 4 m, 8 m, 10 m, 15 m, 20 m, and 30 m (receiver depths greater than 7 m were used to ensure coverage in deeper portions of the model area).
- Frequency range: A frequency range of 10 Hz to 2 kHz was used for the drilling scenario. A wider range of 10 Hz to 5 kHz was used for the pile driving scenario, due to the greater high-frequency content of the vibratory driver source levels (Figure 2(b)).
- Bathymetry: Bathymetry data were obtained from the NGDC US Coastal Relief model (Divins and Metzger 2007); the horizontal resolution of this data set is 3 arc-seconds.
- Geoacoustic properties: The bottom was assumed to consist of 5 m of fine sand overlying two limestone layers (Gaboury *et al.* 2008). The geoacoustic profile was constructed based on values suggested by Hamilton (1980), and is summarized in Table 2 below.
- Sound speed profile: The sound speed profile was obtained from GDEM, for the month of January. As plotted in Gaboury *et al.* (2008), the sound velocity is an almost constant 1514 m/s over the short water column.

Table 2: Tampa Bay geoacoustic profile

Depth (m)	Description	Density (g/cm^3)	P-wave		S-wave	
			Velocity (m/s)	Attenuation	Velocity (m/s)	Attenuation
0–5	unconsolidated sandy sediment	1.8-1.85	1700–1750	0.8	200	0.1
5–125	soft limestone	2.5	2500	0.25		
>125	hard limestone	2.7	3500	0.13		

4 Model Results

The MONM propagation mode was run in the full n × 2-D sense as described in Gaboury *et al.* (2008). Geographically rendered maps of the estimated received sound levels generated by drilling and vibratory driving at the inshore pipelay site are shown in Figure 3 for un-weighted model results. Radii to threshold values of 120 to 180 dB re 1 µPa are shown in Table 3. In addition to the un-weighted model results, radii are shown for M-weightings corresponding to low-frequency cetaceans, mid-frequency cetaceans, and pinnipeds in water. The application of M-weightings, including approximations that may be applied for sea turtles and manatees, is discussed in detailed in Gaboury *et al.* (2008). In each case, the 95^{th} percentile is tabulated, based on maximum received levels over all modeled receiver depths up to seafloor depth. Given a regularly gridded spatial distribution of modeled received levels, this defines the radius of a circle that encompasses 95% of the grid points whose value is equal to or greater than the threshold value.

As expected given the low source levels for drilling (Section 2.2), and as with the HDD scenario modeled by Gaboury and Carr (2009), drilling of the pilot holes is expected to generate only low levels of underwater noise. The estimated 95th percentile radius to a received level of 120 dB re 1 µPa is 240 m for the un-weighted model results (less for the weighted levels), and the source levels for this activity are well below the Level A criterion of 180 dB re 1 µPa. These estimates are for the drill and support barge only; the presence of active support vessels (e.g., tugs) could significantly increase the insonified area.

In contrast, vibratory driving is among the loudest of the scenarios modeled for the Port Dolphin project (see Gaboury *et al.*, 2008), with levels in excess of 120 dB re 1 µPa occurring out to a range of 12.6 km. However, vibratory driving would occur only for brief periods of time; installation of all four goal posts at a single HDD site is expected to require a total of four 24-h days, with vibratory driving used only for a relatively small portion of the total operation. Received levels are not expected to attain the Level A criterion of 180 dB re 1 µPa, even for the relatively conservative (i.e., tending to over-estimate noise generation) scenario modeled in this report.

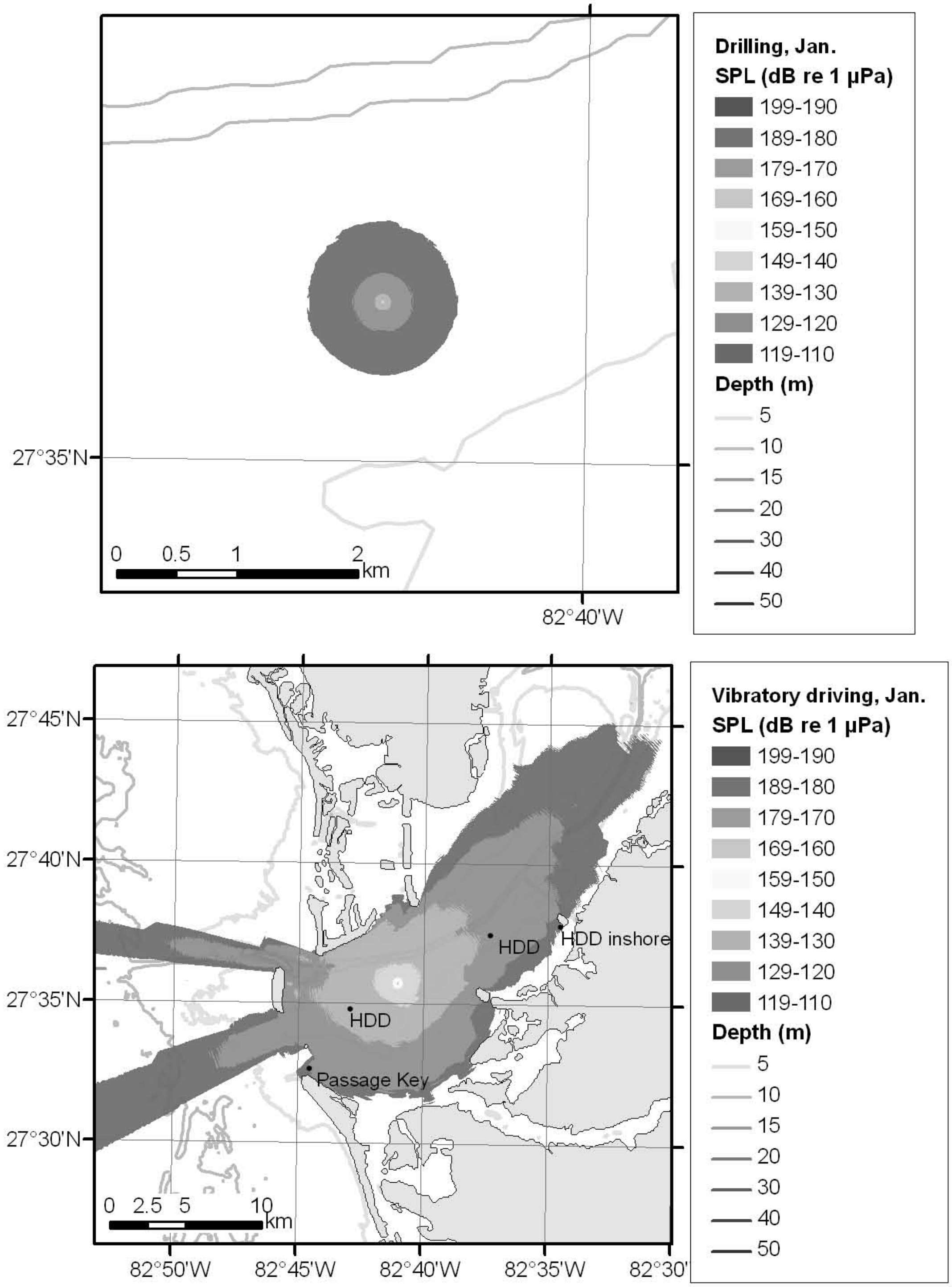

Figure 3: Estimated received sound levels for goal post installation at the inshore pipelay site (located between the two proposed HDD sites). Model results are shown for installation by drilling (upper panel) and vibratory driving (lower panel).

Table 3: 95th percentile radii for goal post installation by drilling and by vibratory driving. Radii corresponding to Level A and Level B harassment criteria are shown in bold italics. Model resolution is 10 m.

SPL (dB re 1 μPa)	95th percentile radius (km)							
	Un-weighted		M_{lf}		M_{mf}		M_{pinn}	
	Drilling	Pile driving	Drilling	Pile driving	Drilling	Pile driving	Drilling	Pile driving
120	***0.24***	***12.63***	***0.24***	***12.51***	***0.18***	***12.60***	***0.22***	***12.61***
130	0.07	5.42	0.07	5.33	0.06	5.37	0.06	5.40
140	0.01	1.54	0.01	1.53	<0.01	1.53	0.01	1.54
150	<0.01	0.38	<0.01	0.37	<0.01	0.36	<0.01	0.37
160	<0.01	0.07	<0.01	0.07	<0.01	0.05	<0.01	0.06
170	<0.01	0.01	<0.01	0.01	<0.01	0.01	<0.01	0.01
180	***<0.01***	***<0.01***	***<0.01***	***<0.01***	***<0.01***	***<0.01***	***<0.01***	***<0.01***

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6 Revision History

Version	Date	Description	Approved by:
1.0	06 May 2010	First release version	Isabelle Gaboury

Appendix E

Level B Harassment Sound Field Graphics

Figure E-1 Installation Buffer Zones Relative to 37 m Bathymetry Contour in the Buoy Area

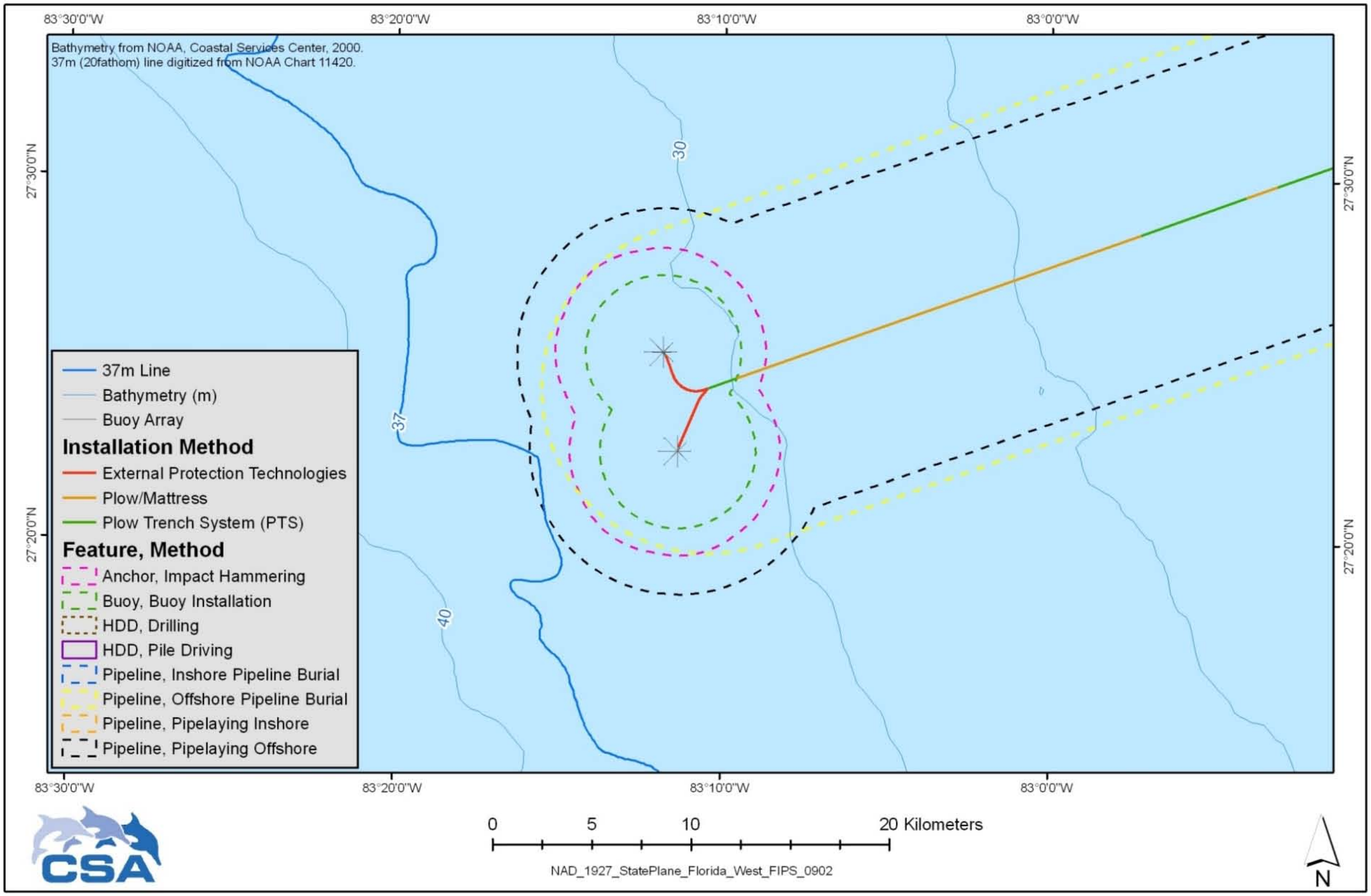

Figure E-2 Installation Acoustic Buffer Areas Relative to Manatee Protection Zones

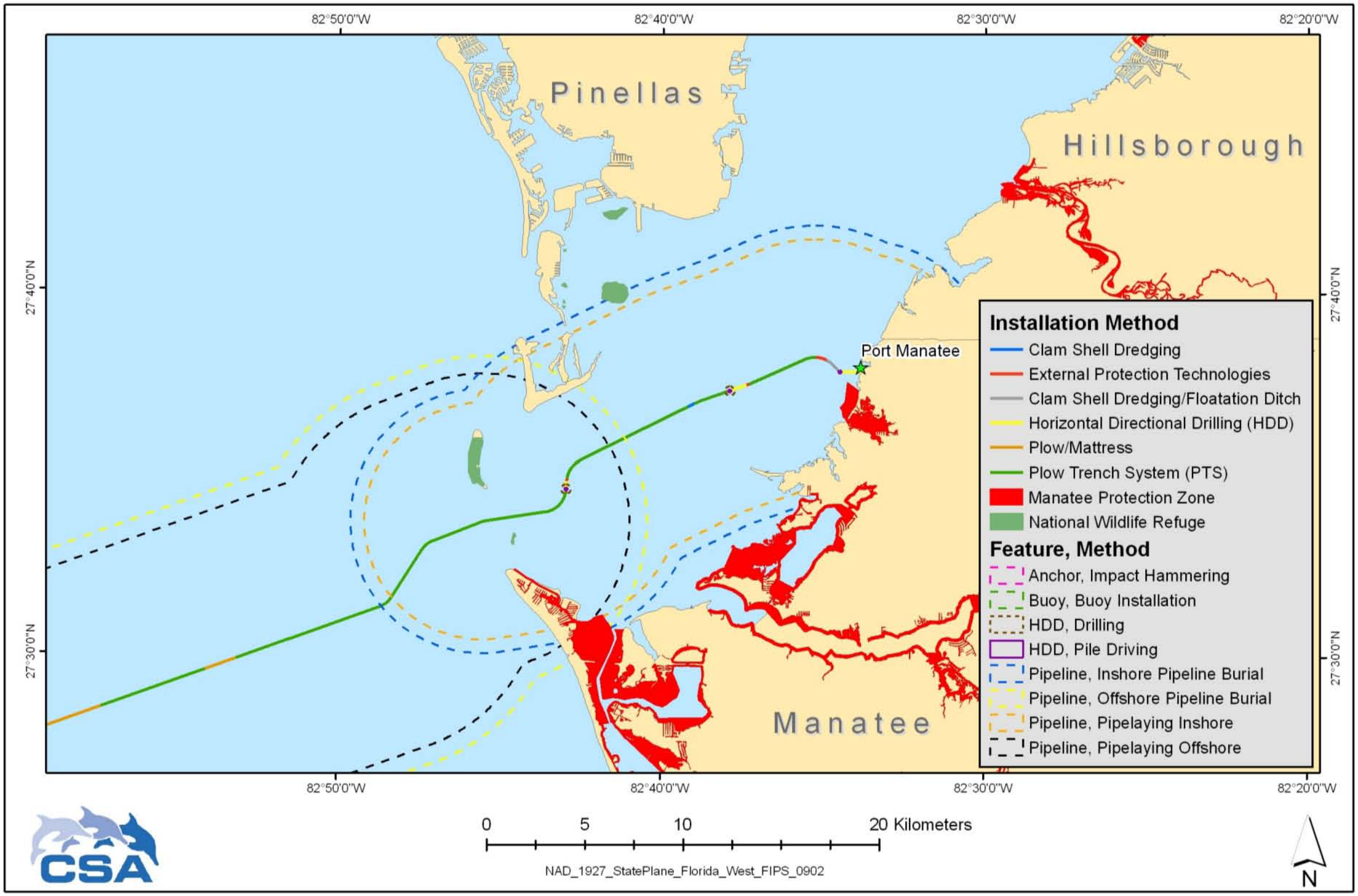

Figure E-3 Transit Route and Docking Buffers Relative to 37 m Contour