REPORT

Bay State Wind Offshore Wind Farm – Request for the Taking of Marine Mammals Incidental to the Use of Dynamically Positioned Vessel Thrusters during the Site Characterization of the DONG Energy Bay State Wind Offshore Wind Farm Lease Area

Prepared	Jennifer Daniels (Tetra Tech), 23 October 2015
Checked	Jennifer Brack (JBRAC), 25 March 2016
Accepted	Jennifer Brack (JBRAC), 25 March 2016
Approved	Pernille Hermansen (PEHER), 25 March 2016

Doc. no.	2395132
Ver. no.	v.2
Case no.	200-15-0979

Table of Contents

1. Description of Specified Activity 1
   - 1.1 Survey Activities 1
   - 1.2 Survey Activities Resulting in the Potential Incidental Taking of Marine Mammals 3
2. Dates, Duration, and Specific Geographic Region 5
   - 2.1 Survey Activity Dates and Duration 5
   - 2.2 Specific Geographic Region 5
3. Species and Numbers of Marine Mammals 5
4. Affected Species Status and Distribution 7
   - 4.1 Toothed Whales (Odontonceti) 7
   - 4.2 Baleen Whales (Mysticeti) 10
   - 4.3 Earless Seals (Phocidae) 15
5. Type of Incidental Taking Requested 16
   - 5.1 Bay State Wind Marine Site Characterization Survey Activities 17
6. Take Estimates for Marine Mammals 17
   - 6.1 Basis for Estimating Numbers of Marine Mammals that Might be “Taken by Harassment” 17
   - 6.2 Estimate of Numbers of Marine Mammals that Might be “Taken by Harassment” 19
     - 6.2.1 Estimate of Potential DP Thrusters Takes by Harassment 20
7. Anticipated Impacts of the Activity 20
8. Anticipated Impacts on Subsistence Uses on Subsistence Uses 21
9. Anticipated Impacts on Habitat 21
10. Anticipated Effects of Habitat Impacts on Marine Mammals 21
11. Mitigation Measures 21
   - 11.1 Vessel Strike Avoidance Procedures 21
   - 11.2 Seasonal Operating Requirements 22
   - 11.3 Visual Monitoring Program 23
   - 11.4 Passive Acoustic Monitoring Program 24
   - 11.5 Ramp-Up Procedures 24
   - 11.6 Shut-Down and Power-Down Procedures 24
12. Arctic Plan of Cooperation 24
13. Monitoring and Reporting 25

13.1 Monitoring 25
13.2 Reporting 25
14. Suggested Means of Coordination Research 25
15. List of Preparers 26
16. References 27

List of Tables

Table 1-2 NMFS Marine Mammal Noise Criteria (NMFS 2005) 3
Table 1-3 Worst-Case Modeled Distances to MMPA Thresholds for Maine Mammals 5
Table 6-1 Functional Hearing Range of Marine Mammals with the Potential to Occur within Lease Area 18
Table 6-2 Marine Mammal Density and Estimated Level B Harassment Take Numbers during DP Thruster Activities 20

List of Figures

Figure 1-1 Project Location 2

List of Appendices

Appendix A DP Thruster Hydroacoustic Assessment
Appendix B Mitigation and Monitoring Communications Flow Diagram

Acronyms and Abbreviations

µPa	microPascal
Applicant	DONG Energy Massachusetts (U.S.), LLC
BOEM	Bureau of Ocean Energy Management
CeTAP	Cetacean and Turtles Assessment Program
CFR	Code of Federal Regulations
cm	centimeter
CPT	cone penetration test
dB	decibel
DMA	Dynamic Management Area
DoN	U.S. Department of the Navy
DP	Dynamically Positioned
EA	Environmental Assessment
EPA	U.S. Environmental Protection Agency
ESA	Endangered Species Act
FLIDAR	floating light and detection ranging buoy
ft	foot
GPS	global positioning system
Hz	hertz
IHA	Incidental Harassment Authorization
in	inch
IUCN	World Conservation Union
IWC	International Whaling Commission
km	kilometer
km^2	square kilometer
km/h	kilometer per hour
kHz	kilohertz
m	meter
MA	Massachusetts
mi	mile
MMPA	Marine Mammal Protection Act
MW	megawatt
nm	nautical mile
NOAA	National Oceanic and Atmospheric Administration
NMFS	National Marine Fisheries Service
OCS	Outer Continental Shelf
OPAREA	Operations Area
PAM	Passive Acoustic Monitoring
PSO	Protected Species Observer
RAM	Range-Dependent Acoustic Model
RMS	root mean square
SMA	Seasonal Management Area
SPUE	sightings per unit effort
WEA	Wind Energy Area
ZOI	Zone of Influence

1. Description of Specified Activity

DONG Energy Massachusetts (U.S.) LLC (the Applicant) is proposing to conduct marine site characterization surveys off the coast of Massachusetts in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease Area; Figure 1-1). The Applicant submits this request for Incidental Harassment Authorization (IHA) pursuant to Section 101(a)(5) of the Marine Mammal Protection Act (MMPA) and 50 Code of Federal Regulations (CFR) § 216 Subpart I to allow for the incidental harassment of small numbers of marine mammals resulting from the execution of marine site characterization surveys in the Lease Area specifically associated with the operation of dynamically positioned (DP) vessel thrusters during geotechnical survey activities.

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 immitigable adverse impact on the availability of the marine mammal species or stock(s) for certain subsistence uses. In order for the National Oceanic and Atmospheric Administration (NOAA) National Marine Fisheries Service (NMFS) to consider authorizing the taking by U.S. citizens of small numbers of marine mammals incidental to a specified activity (other than commercial fishing), or to make a finding that incidental take is unlikely to occur, a written request must be submitted to the Assistant Administrator. Such a request is detailed in the following sections.

1.1 Survey Activities

The Applicant will conduct marine site characterization surveys in the marine environment of the approximately 187,532-acre Lease Area located approximately 14 miles (mi) south of Martha's Vineyard, Massachusetts, at its closest point (see Figure 1-1). Marine site characterization surveys will involve the following geotechnical survey activities:

- Sample boreholes to determine geological and geotechnical characteristics of sediments;
- Deep cone penetration tests (CPTs) to determine stratigraphy and in-situ conditions of the deep surface sediments;
- Shallow CPTs to determine stratigraphy and in-situ conditions of the near surface sediments; and
- Vibrocoring to determine geological and geotechnical characteristics of the near surface sediments.

The purpose of the geotechnical surveys is to:

- Support the siting, design, and deployment of up to two meteorological data collection buoys referred to as floating light and detection ranging buoys (FLIDARs) and up to two metocean and current buoys; and
- Obtain a baseline assessment of seabed/sub-surface soil conditions in the DONG Energy Massachusetts Lease Area to support the siting of the proposed wind farm.

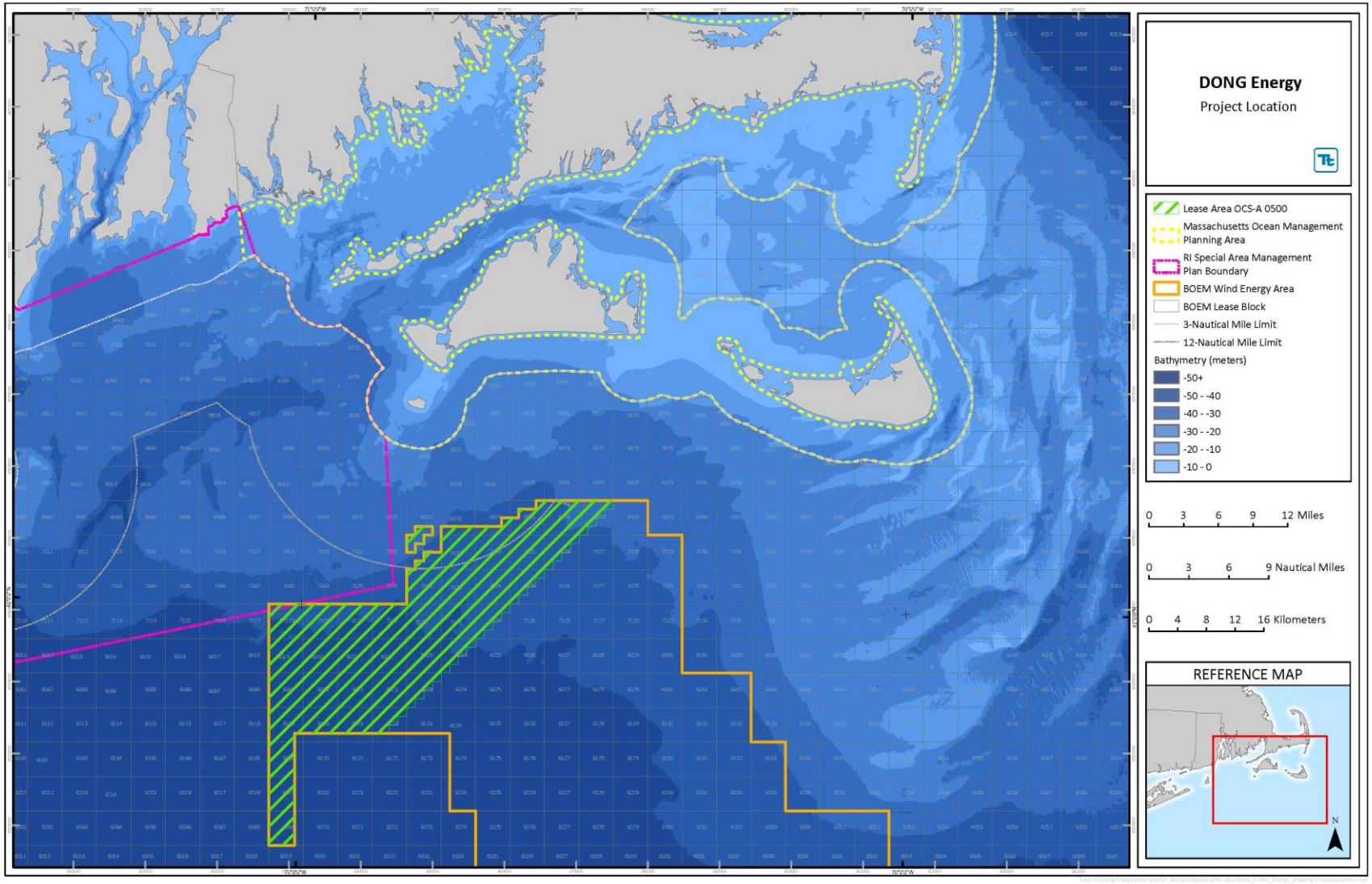

Figure 1-1 Project Location

It is anticipated that the geotechnical surveys will take place no sooner than September of 2016. The geotechnical survey program will consist of up to 4 deep sample bore holes and adjacent 4 deep CPTs both to a depth of approximately 131ft to 164 ft (40 m to 50 m) below the seabed, 15 shallow CPTs, and 15 adjacent vibrocores, both up to 20 ft (6 m) below seabed.

The investigation activities are anticipated to be conducted from a 250-ft to 350-ft (76 m to 107 m) dynamically positioned (DP) drill ship. Operations will take place over a 24-hour period to ensure cost, the duration of survey activities, and the period of potential impact on marine species are minimized. Based on 24-hour operations, the estimated duration of the geotechnical survey activities would be approximately 6 days excluding weather downtime. Estimated weather downtime is approximately 4 to 5 days.

Field studies conducted off the coast of Virginia (Tetra Tech 2014) to determine the underwater noise produced by borehole drilling and CPTs confirm that these activities do not result in underwater noise levels that are harassing or harmful to marine mammals. However, underwater noise produced by the thrusters associated with the DP drill ship that will be used to support the geotechnical activities has the potential to result in Level B Harassment of marine mammals.

1.2 Survey Activities Resulting in the Potential Incidental Taking of Marine Mammals

The potential effects of underwater noise resulting in takes on marine mammals are federally managed by NOAA under the MMPA to minimize the potential for both harm and harassment. Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild; however, the actionable sound pressure level is not identified in the statute. NOAA defines the Level A Harassment zone of injury to marine mammals as the range of received sound pressure levels from 180 decibels (dB) referenced to 1 microPascal (µPa) root mean square (RMS), for mysticetes and odontocetes within the 180 dB_{RMS} re 1µPa sound exposure limit, and 190 dB_{RMS} re 1µPa for pinnipeds. This threshold considers instantaneous sound pressure levels at a given receiver location. The NOAA 180 dB_{RMS} re 1 µPa guideline is designed to protect all marine species from high sound pressure levels at any discrete frequency across the entire frequency spectrum. It is a very conservative criterion as it does not consider species-specific hearing capabilities.

The MMPA defines Level B harassment as any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. NOAA has defined the threshold level for Level B harassment at 120 dB_{RMS} re 1 µPa for continuous noise and 160 $dB_{RMS90\%}$ re 1 µPa for impulse noise. Within this zone, the sound produced by DP thrusters may approach or exceed ambient sound levels (i.e., threshold of perception or zone of audibility); however, actual perceptibility will be dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels.

A summary of the NOAA cause and effect noise criteria are summarized in Table 1-2.

Table 1-2 NMFS Marine Mammal Noise Criteria (NMFS 2005)

	Criteria Level	Type
Marine Mammals		
Level A Harassment (Injury) - Mysticetes and Odontocetes	180 dB_{RMS} re 1 µPa	Absolute
Level A Harassment (Injury) - Pinnipeds	190 dB_{RMS} re 1 µPa	Absolute
Level B Harassment (Disturbance)	160 $dB_{RMS90\%}$ re 1 µPa 120 dB_{RMS} re 1 µPa	Impulse Continuous

The Applicant's survey activities that could result in the incidental take of marine mammals are limited to Level B harassment caused by the generation of underwater noise from the operation of DP vessel thrusters in support of geotechnical survey activities as described in Section 1.1.

To better understand both the level and extent of underwater noise generated by Project activities and their potential to impact marine species, the Applicant conducted a hydroacoustic modeling exercise of the DP drill ship thrusters to predict the potential acoustic zone of influence (ZOI) associated with their use. Modeling took into consideration the following factors:

- **Sound sources:** DP vessel thrusters were using the loudest potential operational parameters, which are expected to be well beyond the needs of this survey.
- **Bathymetry:** Seabed topography was included in the model, which provided site-specific boundary conditions that has an effect on underwater sound propagation and attenuation by shielding, refracting or reflecting sound. Given the size of the survey area, calculations were done at three representative water depths, 125 ft, 144 ft, and 177 ft (38 m, 44 m and 54 m).
- **Geoacoustic properties (e.g., hard rock, sand, mud) of the Lease Area:** The physical properties of the seabed were characterized (e.g., density, compressional and shear attenuation). These varying properties govern the sound speed and transmission loss of acoustic signals through sediment and the model calculates the bottom attenuation and the reflecting differences in the speed of sound to determine bottom attenuation loss.
- **Time of Year:** The sound speed profile has an influence on sound attenuation and varies by location and month. As the proposed survey activities will likely occur in September, the sound speed profile for this month was evaluated.
- **Marine mammal hearing ranges:** Only the marine mammal species known to occur in the Lease Area at the time of the proposed survey activities were evaluated.

In addition to the above modeling assumptions, estimates for the representative source level of the operating DP thrusters were also applied. To estimate the representative DP thruster source level, a review of representative acoustic data from similar vessels was undertaken. Since thrusters and power output (horsepower [HP]) vary between vessels, source levels were adjusted to account for the expected power output of the DP thrusters during survey operations. For the purpose of this survey, it was assumed that DP thrusters would operate at maximum output of not more than 50 percent. The complete Hydroacoustic Modeling Assessment (Appendix A) provides more details. Results from that assessment are summarized in Table 1-3. Results of the analysis showed that across all depths, the estimated maximum critical distance to the 120 dB_{RMS} re 1 μPa MMPA threshold was approximately 3,400 m from the source (see Table 1-3).

Table 1-3 Worst-Case Modeled Distances to MMPA Thresholds for Maine Mammals

Survey Equipment	Marine Mammal Level A Harassment 180 dB_{RMS} re 1 µPa (m)	Marine Mammal Level B Harassment 160 $dB_{RMS90\%}$ re 1 µPa (m)	Marine Mammal Level B Harassment 120 dB_{RMS} re 1 µPa (m)
DP Thrusters – 38 m	0	<5	2,875
DP Thrusters – 44 m	0	<5	3,225
DP Thrusters – 54 m	0	<5	3,400
a/ Not applicable for impulsive noise.			

2. Dates, Duration, and Specific Geographic Region

2.1 Survey Activity Dates and Duration

Geotechnical surveys requiring the use of the DP drill ship will take place in September of 2016, at the earliest, and will last for approximately 6 days excluding weather downtime. This survey schedule is based on 24-hour operations and include estimated weather down time.

2.2 Specific Geographic Region

The Applicant's survey activities will occur in the approximately 187,532-acre Lease Area designated and offered by BOEM. The Lease Area falls within the Massachusetts Wind Energy Area (MA WEA; Figure 1-1). An evaluation of site assessment activities within the MA WEA was fully assessed in the BOEM Environmental Assessment (EA) and associated Finding of No Significant Impact as revised in June 2014. A Biological Opinion on site assessment activities within the MA WEA was issued by NOAA to BOEM in April 2013.

3. Species and Numbers of Marine Mammals

The BOEM (2014) Revised EA reports 38 species of marine mammals (whales, dolphins, porpoise, and seals) in the Northwest Atlantic Outer Continental Shelf (OCS) region that are protected by the MMPA, 6 of which are listed under the ESA and are known to be present, at least seasonally, in the Lease Area (see Table 3-1). A description of the status and distribution of these species are discussed in detail in Section 4.0.

Table 3-1 Marine Mammals Known to Occur in the Marine Waters of Southern New England

Common Name	Scientific Name	NMFS Status	Estimated Population	Stock
Toothed Whales (Odontoceti)				
Atlantic white-sided dolphin	*Lagenorhynchus acutus*	N/A	48,819	W. North Atlantic
Atlantic spotted dolphin	*Stenella frontalis*	N/A	44,715	W. North Atlantic
Bottlenose dolphin	*Tursiops truncates*	Northern coastal stock is Strategic [a/]	11,548	W. North Atlantic, Northern Migratory Coastal
Clymene Dolphin	*Stenella clymene*	N/A	Unknown	W. North Atlantic
Fraser's Dolphin	*Lagenodelphis hosei*	N/A	Unknown	W. North Atlantic
Pan-Tropical Spotted Dolphin	*Stenella attenuata*	N/A	3,333	W. North Atlantic
Risso's dolphin	*Grampus griseus*	N/A	18,250	W. North Atlantic
Rough-Toothed Dolphin	*Steno bredanensis*	N/A	271	W. North Atlantic
Short-beaked common dolphin	*Delphinus delphis*	N/A	120,743	W. North Atlantic
Striped dolphin	*Stenella coeruleoalba*	N/A	46,882	W. North Atlantic
Spinner Dolphin	*Stenella longirostris*	N/A	Unknown	W. North Atlantic
White-beaked dolphin	*Lagenorhynchus albirostris*	N/A	2,003	W. North Atlantic
Harbor porpoise	*Phocoena phocoena*	N/A	79,833	Gulf of Maine/Bay of Fundy
Killer whale	*Orcinus orca*	N/A	Unknown	W. North Atlantic
Pygmy Killer Whale	*Feresa attenuata*	N/A	3,785	W. North Atlantic
False killer whale	*Pseudorca crassidens*	Strategic	442	W. North Atlantic
Long-finned pilot whale	*Globicephala malaena*	N/A	26,535	W. North Atlantic
Short-finned pilot whale	*Globicephala macrorhynchus*	N/A	21,515	W. North Atlantic
Sperm whale	*Physeter macrocephalus*	Endangered	2,288	North Atlantic
Pigmy sperm whale	*Kogia breviceps*	N/A	3,785 [b/]	W. North Atlantic
Dwarf sperm whale	*Kogia sima*	N/A	3,785 [b/]	W. North Atlantic
Cuvier's beaked whale	*Ziphius cavirostris*	N/A	6,532	W. North Atlantic
Blainville's beaked whale	*Mesoplodon densirostris*	N/A	7,092 [c/]	W. North Atlantic
Gervais' beaked whale	*Mesoplodon europaeus*	N/A	7,092 [c/]	W. North Atlantic
True's beaked whale	*Mesoplodon mirus*	N/A	7,092 [c/]	W. North Atlantic
Sowerby's Beaked Whale	*Mesoplodon bidens*	N/A	7,092 [c/]	W. North Atlantic
Northern bottlenose whale	*Hyperoodon ampullatus*	N/A	Unknown	W. North Atlantic
Melon-headed whale	*Peponocephala electra*	W. North Atlantic	W. North Atlantic	W. North Atlantic
Baleen Whales (Mysticeti)				
Minke whale	*Balaenoptera acutorostrata*	N/A	20,741	Canadian East Coast
Blue whale	*Balaenoptera musculus*	Endangered	Unknown	W. North Atlantic
Fin whale	*Balaenoptera physalus*	Endangered	1,618	W. North Atlantic
Humpback whale	*Megaptera novaeangliae*	Endangered	11,570	North Atlantic
North Atlantic right whale	*Eubalaena glacialis*	Endangered	465	W. North Atlantic
Sei whale	*Balaenoptera borealis*	Endangered	357	Nova Scotia
Earless Seals (Phocidae)				
Gray seals	*Halichoerus grypus*	N/A	348,900	North Atlantic
Harbor seals	*Phoca vitulina*	N/A	75,834	W. North Atlantic
Hooded seals	*Cystophora cristata*	N/A	Unknown	W. North Atlantic
Harp seal	*Phoca groenlandica*	N/A	8,300,000	North Atlantic

a/ A strategic stock is defined as any marine mammal stock: 1) for which the level of direct human-caused mortality exceeds the potential biological removal level; 2) which is declining and likely to be listed as threatened under the ESA; or 3) which is listed as threatened or endangered under the ESA or as depleted under the MMPA (http://www.ncseonline. org/nle/crsreports/biodiversity/biodv-11.cfm).

b/ This estimate may include both the dwarf and pygmy sperm whales.

c/ This estimate includes Gervais' and Blainville's beaked whales and undifferentiated Mesoplodon spp. beaked whales.

Sources: Waring et al. 2015; Waring et al 2013; Waring et al 2011; Warring et al 2010; RI SAMP 2011; Kenney and Vigness-Raposa 2009; NMFS 2012

4. Affected Species Status and Distribution

As described in Section 3.0, of the 38 marine mammal species potentially inhabiting the Northwest Atlantic OCS region, six marine mammal species are listed under the ESA and are known to be present, at least seasonally, in the waters of Southern New England: blue whale, fin whale, humpback whale, right whale, sei whale, and sperm whale. These species are highly migratory and do not spend extended periods of time in a localized area. The waters of Southern New England (including the Lease Area) are primarily used as a stopover point for these species during seasonal movements north or south between important feeding and breeding grounds. Some whale species (fin, humpback, and minke whales) are present year-round in the continental shelf and slope waters but are relatively rare in the more shallow waters of the Lease Area and the typical migratory routes for right whales and other baleen whales lie further offshore and outside of the Lease Area (Kenney and Vigness-Raposa 2009). While the fin, humpback, and right whales have the potential to occur within the Lease Area, the sperm, blue, and sei whales are more pelagic and/or northern species and their presence within the Lease Area is possible, but they are considered less common with regards to sightings. In particular, while sperm whales are known to occur occasionally in the region, their sightings are considered rare and thus their presence in the Lease Area at the time of the proposed activities is considered unlikely. However, based on a recent increase in sightings, they are included in the discussion below. Because the potential for the blue whale and sei whale to occur within the Lease Area during the marine survey period is unlikely, these species will not be described further in this analysis.

The following subsections provide additional information on the biology, habitat use, abundance, distribution, and the existing threats to the non-endangered or threatened and endangered marine mammals that are both common in the waters of the OCS south of Massachusetts and have the likelihood of occurring, at least seasonally, in the Lease Area. These species include the minke and long-finned pilot whales, short-beaked common, Atlantic white-sided, bottlenose, and Risso's dolphins, harbor porpoise, and harbor and gray seals (Right Whale Consortium 2014). White-beaked dolphins are likely to occur in the nearby waters surrounding the Lease Area (i.e., within 40 nautical miles [nm] [74 kilometers (km)]), but not in the Lease Area, and beaked whales are likely to occur in the region to the south of the Lease Area, but not within 40 nm (74 km) (Right Whale Consortium 2014). In general, the remaining non-ESA whale species listed in Table 3-1 range outside the DONG Energy Lease Area, usually in more pelagic waters, or are so rarely sighted that their presence in the Lease Area is unlikely.

4.1 Toothed Whales (Odontonceti)

Sperm Whale (*Physeter macrocephalus*) – Endangered

Currently, there is no reliable estimate for the total number of sperm whales worldwide. The best estimate is that there are between 200,000 and 1,500,000 sperm whales, based on extrapolations from only a few areas that have useful estimates (NMFS 2006). Estimates show about 1,665 in the northern Gulf of Mexico, 14,000 in the North Atlantic, 80,000 in the North Pacific, and 9,500 in the Antarctic (NMFS 2006; Waring et al. 2009). For the western North Atlantic, the minimum population size has been estimated at 1,815 individuals (Waring et al. 2014).

Sperm whales are highly social, with a basic social unit consisting of 20 to 40 adult females, calves, and some juveniles (Rice 1989; Whitehead 2008). During their prime breeding period and old age, male sperm whales are essentially solitary. Males rejoin or find nursery groups during prime breeding season. While foraging, the whales typically gather in small clusters. Between diving bouts, sperm whales are known to raft together at the surface. Adult males often forage alone. Groups of females may spread out over distances greater than 0.5 nm when foraging. When socializing, they generally gather into larger surface-

active groups (Jefferson et al. 2008; Whitehead 2003). In the Northern Hemisphere, the peak breeding season for sperm whales occurs between March and June, and in the Southern Hemisphere, the peak breeding season occurs between October and December (NMFS 2009).

This species primarily preys on squid and octopus and are also known to prey on fish, such as lumpsuckers and redfish. Although sperm whales are generalists in terms of prey, specialization does appear to occur in a few places. The main sperm whale feeding grounds are correlated with increased primary productivity caused by upwelling.

The sperm whale is thought to have a more extensive distribution than any other marine mammal, except possibly the killer whale. This species is found in polar to tropical waters in all oceans, from approximately 70° N to 70° S (Rice 1989; Whitehead 2003). It ranges throughout all deep oceans of the world, essentially from equatorial zones to the edges of the polar pack ice. In the Atlantic, sperm whales are found throughout the Gulf Stream and North Central Atlantic Gyre. The current abundance estimate for this species in the North Atlantic is 2,288 individuals. The species is listed as Endangered (Waring et al. 2015).

Sperm whales show a strong preference for deep waters (Rice 1989; Whitehead 2003). Their distribution is typically associated with waters over the continental shelf break and the continental slope and into deeper waters (Jefferson et al. 2008; Whitehead et al. 1992). Sperm whale concentrations near drop-offs and areas with strong currents and steep topography are correlated with high productivity. These whales occur almost exclusively found at the shelf break, regardless of season (NYDOS 2013). Sperm whales are somewhat migratory; however, their migrations are not as specific as seen in most of the baleen whale species. In the North Atlantic, there appears to be a general shift northward during the summer, but there is no clear migration in some temperate areas (Rice 1989; Whitehead 2003).

Harbor Porpoise (*Phocoena phocoena*) – Non-Strategic

The harbor porpoise inhabits shallow, coastal waters, often found in bays, estuaries, and harbors. In the western Atlantic, they are found from Cape Hatteras north to Greenland. They are likely to occur frequently in southern New England waters within all seasons, but are most likely to reach their highest densities in spring when migration brings them toward the Gulf of Maine feeding grounds from their wintering areas offshore and in the mid-Atlantic (Kenney and Vigness-Raposa 2009). After April, they migrate north towards the Gulf of Maine and Bay of Fundy. Kenney and Vigness-Raposa (2009) report that harbor porpoises are among the most abundant cetaceans in southern New England coastal waters. Harbor porpoises are the smallest North Atlantic cetacean, measuring at only 1.4 to 1.9 m, and feed primarily on fish, but also prey on squid and crustaceans (Reeves and Read 2003; Kenney and Vigness-Raposa 2009). Sighting records from the 1978 to 1981 Cetacean and Turtle Assessment Program (CeTAP) surveys showed porpoises in spring exhibited highest densities in the southwestern Gulf of Maine in proximity to the Nantucket Shoals and western Georges Bank, with presence throughout the southern New England shelf and Gulf of Maine (CeTAP 1982). While strandings have occurred throughout the south shore of Long Island and coastal Rhode Island, many sightings have occurred offshore in the OCS area (Kenney and Vigness-Raposa 2009). The North Atlantic harbor porpoise population is likely to be over 500,000 (Kenney and Vigness-Raposa 2009). The current population estimate for harbor porpoise in the Gulf of Maine/Bay of Fundy is 79,833 (Waring et al. 2015).

The most common threat to the harbor porpoise is from incidental mortality from fishing activities, especially from bottom-set gillnets. It has been demonstrated that the porpoise echolocation system is capable of detecting net fibers, but they either must not have the “system activated” or else they fail to recognize the nets (Reeves et al. 2002). Roughly 365 harbor porpoises are killed by human-related activities in U.S. and

Canadian waters each year. In 1999, a Take Reduction Plan to reduce harbor porpoise bycatch in U.S. Atlantic gillnets was implemented. The plan that pertains to the Gulf of Maine focuses on sink gillnets and other gillnets that can catch groundfish in New England waters. The ruling implements time and area closures, some of which are complete closures, as well as requiring pingers on multispecies gillnets. In 2001, the harbor porpoise was removed from the candidate species list for the ESA; a review of the biological status of the stock indicated that a classification of "Threatened" was not warranted (Waring et al. 2009). This species has been listed as "non-strategic" because average annual human-related mortality and injury does not exceed the potential biological removal (Waring et al. 2015).

Atlantic White-Sided Dolphin (*Lagenorhynchus acutus*) – Non-Strategic

The Atlantic white-sided dolphin is typically found at a depth of 330 ft (100 m) in the cool temperate and subpolar waters of the North Atlantic, generally along the continental shelf between the Gulf Stream and the Labrador current to as far south as North Carolina (Bulloch 1993; Reeves et al. 2002; Jefferson et al. 2008). They are the most abundant dolphin in the Gulf of Maine and the Gulf of St. Lawrence, but seem relatively rare along the North Atlantic coast of Nova Scotia (Kenney and Vigness-Raposa 2009).

Atlantic white-sided dolphins range between 2.5 m and 2.8 m in length, with females being approximately 20 cm shorter than males (Kenney and Vigness-Raposa 2009). This species is highly social and is commonly seen feeding with fin whales (NOAA 1993). White-sided dolphins feed on a variety of small species, such as herring, hake, smelt, capelin, cod, and squid, with regional and seasonal changes in the species consumed (Kenney and Vigness-Raposa 2009). Sand lance is an important prey species for these dolphins in the Gulf of Maine during the spring. Other fish prey include mackerel, silver hake, herring, smelt, and several other varieties of gadoids (Kenney and Vigness-Raposa 2009). There are seasonal shifts in the distribution of Atlantic white-sided dolphins off the northeastern U.S. coast, with low abundance in winter between Georges Basin and Jeffrey's Ledge and very high abundance in the Gulf of Maine during spring. During the summer, Atlantic white-sided dolphins are most abundant between Cape Cod and the lower Bay of Fundy. During the fall, the distribution of Atlantic white-sided dolphins is similar to that in the summer, although they are less abundant (Department of the Navy [DoN] 2005). Recent population estimates for Atlantic white-sided dolphins in the Western North Atlantic Ocean places this species at 48,819 individuals (Waring et al. 2015). This species can be found off the coast of southern New England during all seasons of the year, but is usually most numerous in areas farther offshore at depth range of 330 ft (100 m) (Kenney and Vigness-Raposa 2009; Bulloch 1993; Reeves et al. 2002).

The biggest human-induced threat to the Atlantic white-sided dolphin is bycatch, because they are occasionally caught in fishing gillnets and trawling equipment. An estimated average of 328 dolphins each year were killed by fishery-related activities during 2003 to 2007 (Waring et al. 2010). From 2008 through 2012, an estimated annual average of 116 dolphins per year were killed (Waring et al. 2015). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2011; 2015).

Short-Beaked Common Dolphin (*Delphinus delphis*) – Non-Strategic

The short-beaked dolphin is one of the most widely distributed cetaceans and occurs in temperate, tropical, and subtropical regions (Jefferson et al. 2008). Short-beaked dolphins feed on squids and small fish, including species that school in proximity to surface waters as well as mesopelagic species found near the surface at night (World Conservation Union [IUCN] 2010; NatureServe 2010). They have been known to feed on fish escaping from fishermen's nets or fish that are discarded from boats (NOAA 1993). This species is found between Cape Hatteras and Georges Bank from mid-January to May, although they migrate onto Georges Bank and the Scotian Shelf between mid-summer and fall, where large aggregations occur on

Georges Bank in fall (Waring et al. 2007). These dolphins can gather in schools of hundreds or thousands, although the schools generally consist of smaller groups of 30 or fewer. They are eager bow riders and are active at the surface (Reeves et al. 2002). The short-beaked common dolphin feeds on small schooling fish and squid. While this dolphin species can occupy a variety of habitats, short-beaked common dolphins occur in greatest abundance within a broad band of the northeast edge of Georges Bank in the fall (Kenney and Vigness-Raposa 2009). According to the species stock report, the best population estimate for the western North Atlantic common dolphin is approximately 120,743 individuals (Waring et al. 2015).

Short-beaked common dolphins can be found either along the 650- to 6,500-ft (200- to 2,000-m) isobaths over the continental shelf and in pelagic waters of the Atlantic and Pacific Oceans. They are present in the western Atlantic from Newfoundland to Florida. The short-beaked common dolphin is especially common along shelf edges and in areas with sharp bottom relief such as seamounts and escarpments (Reeves et al. 2002). They show a strong affinity for areas with warm, saline surface waters. Off the coast of the eastern United States, they are particularly abundant in continental slope waters from Georges Bank southward to about 35 degrees north (Reeves et al. 2002) and usually inhabit tropical, subtropical, and warm-temperate waters (Waring et al. 2009).

The short-beaked common dolphin is also subject to bycatch. It has been caught in gillnets, pelagic trawls, and during longline fishery activities. During 2004 to 2008, it was estimated that on average approximately 167 dolphins were killed each year by human activities (Waring et al. 2010). This number increased to 289 dolphins during 2008 to 2012 (Waring et al. 2015). This species is also the most common dolphin species to be stranded along the southern New England Coast (Kenney and Vigness-Raposa 2009). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2009; 2010; 2015).

4.2 Baleen Whales (Mysticeti)

North Atlantic Right Whale (*Eubalaena glacialis*) – Endangered

The North Atlantic right whale is a strongly migratory species that moves annually between high-latitude feeding grounds and low-latitude calving and breeding grounds. This species was listed as a federally endangered species in 1970 and is one of the most endangered large whale species in the world. The North Atlantic right whale has seen a nominal 2 percent recovery rate since it was listed as a protected species (NOAA Fisheries 2015). This is a drastic difference from the stock found in the Southern Hemisphere, which has increased at a rate of 7 to 8 percent (Knowlton and Kraus 2001). The historic range of this species reached its southern terminus between Florida and northwestern Africa and its northern terminus between Labrador and Norway (Kenney 2002). The present range of the western North Atlantic right whale population extends from the southeastern United States, which is utilized for wintering and calving, to summer feeding and nursery grounds between New England and the Bay of Fundy and the Gulf of St. Lawrence (Kenney 2002; Waring et al. 2007). Observations in December 2008 noted congregations of more than 40 individual right whales in the Jordan Basin area of the Gulf of Maine, leading researchers to believe this may be a wintering ground (NOAA 2008). A right whale satellite tracking study within the northeast Atlantic (Baumgartner and Mate 2005) reported that this species often visited waters exhibiting low bottom water temperatures, high surface salinity, and high surface stratification, most likely for higher food densities. The winter distribution of North Atlantic right whales is largely unknown, although offshore surveys have reported between one and 13 detections annually in northeastern Florida and southeastern Georgia (Waring et al. 2007). A few documented events of right whale calving have been from shallow coastal areas and bays (Kenney 2002). North Atlantic right whales may be found in feeding grounds within

New England waters between February and May, with peak abundance in late March (NOAA 2005). While in New England, right whales feed mostly on copepods belonging to the *Calanus* and *Pseudocalanus* genus (Waring et al. 2007). Right whales are considered grazers as they swim slowly with their mouths open. They are the slowest swimming whales and can only reach speeds up to 10 mi (16 km) per hour. They can dive at least 1,000 ft (300 m) and stay submerged for typically 10 to 15 minutes, feeding on their prey below the surface (ACSonline 2004).

The North Atlantic right whale was the first species targeted during commercial whaling operations and was the first species to be greatly depleted as a result of whaling operations (Kenney 2002). North Atlantic right whales were hunted in southern New England until the early twentieth century. Shore-based whaling in Long Island involved catches of right whales year-round, with peak catches in spring during the northbound migration from calving grounds off the southeastern United States to feeding grounds in the Gulf of Maine (Kenney and Vigness-Raposa 2009). Abundance estimates for the North Atlantic right whale population vary. From the 2003 United States Atlantic and Gulf of Mexico Marine Mammal Stock Assessments, there were only 291 North Atlantic right whales in existence, which is less than what was reported in the Northern Right Whale Recovery Plan written in 1991 (NMFS 1991a; Waring et al. 2004). This is a tremendous difference from pre-exploitation numbers, which are thought to be around 1,000 individuals. When the right whale was finally protected in the 1930s, it is believed that the North Atlantic right whale population was roughly 100 individuals (Waring et al. 2004). In 2014, the Western North Atlantic population size was estimated to be at least 465 individuals (Waring et al. 2013)

Contemporary anthropogenic threats to right whale populations include fishery entanglements and vessel strikes, although habitat loss, pollution, anthropogenic noise, and intense commercial fishing may also negatively impact their populations (Kenney 2002). Ship strikes of individuals can impact northern right whales on a population level due to the intrinsically small remnant population that persists in the North Atlantic (Laist et al. 2001). Between 2002 and 2006, a study of marine mammal stranding and human-induced interactions reported that right whales in the western Atlantic were subject to the highest proportion of entanglements (25 of 145 confirmed events) and ship strikes (16 of 43 confirmed occurrences) of any marine mammal studied (Glass et al. 2008). Bycatch of North Atlantic right whale has also been reported in pelagic drift gillnet operations by the Northeast Fisheries Observer Program, however, no mortalities have been reported (Glass et al. 2008). From 2008 through 2012, the minimum rate of annual human-caused mortality and serious injury to this species from fishing entanglements averaged 3.65 per year, while ship strikes averaged 0.9 whales per year (Waring et al. 2015). The NOAA marine mammal stock assessment for 2014 reports that the low annual reproductive rate of right whales, coupled with small population size, suggests anthropogenic mortality may have a greater impact on population growth rates for the species than for other whales (Waring et al. 2015).

Most ship strikes are fatal to the North Atlantic right whales (Jensen and Silber 2004). Right whales have difficulty maneuvering around boats and spend most of their time at the surface, feeding, resting, mating, and nursing, increasing their vulnerability to collisions. Mariners should assume that North Atlantic right whales will not move out of their way nor will they be easy to detect from the bow of a ship for they are dark in color and maintain a low profile while swimming (World Wildlife Fund 2005). To address potential for ship strike, NMFS designated the nearshore waters of the Mid-Atlantic Bight as the Mid-Atlantic U.S. Seasonal Management Area (SMA) for right whales. NMFS requires that all vessels 65 ft (19.8 m) or longer must travel at 10 knots or less within the right whale SMA from November 1 through April 30 when right whales are most likely to pass through these waters (NOAA 2010).

Right whales have been observed in or near southern New England during all four seasons; however, they are most common in the spring when they are migrating north and in the fall during their southbound migration (Kenney and Vigness-Raposa 2009).

Humpback Whale (*Megaptera novaeangliae*) – Endangered

The humpback whale was listed as endangered in 1970 due to population decrease resulting from overharvesting. Humpback whales feed on small prey that is often found in large concentrations, including krill and fish such as herring and sand lance (Waring et al. 2007; Kenney and Vigness-Raposa 2009). Humpback whales are thought to feed mainly while migrating and in summer feeding areas; little feeding is known to occur in their wintering grounds. Humpbacks feed over the continental shelf in the North Atlantic between New Jersey and Greenland, consuming roughly 95 percent small schooling fish and 5 percent zooplankton (i.e., krill), and they will migrate throughout their summer habitat to locate prey (Kenney and Winn 1986). They swim below the thermocline to pursue their prey, so even though the surface temperatures might be warm, they are frequently swimming in cold water (NMFS 1991b). Humpback whales from all of the North Atlantic migrate to the Caribbean in winter, where calves are born between January and March (Blaylock et al. 1995).

Humpback whales exhibit consistent fidelity to feeding areas within the northern hemisphere (Stevick et al. 2006). There are six subpopulations of humpback whales that feed in six different areas during spring, summer and fall. These feeding populations can be found in the Gulf of Maine, the Gulf of St. Lawrence, Newfoundland/Labrador, western Greenland, Iceland, and Norway (Waring et al. 2015). The highest abundance for humpback whales is distributed primarily along a relatively narrow corridor following the 328-ft (100-m) isobath across the southern Gulf of Maine from the northwestern slope of Georges Bank, south to the Great South Channel, and northward alongside Cape Cod to Stellwagen Bank and Jeffreys Ledge. In winter, whales from waters off New England, Canada, Greenland, Iceland, and Norway migrate to mate and calve primarily in the West Indies (including the Antilles, the Dominican Republic, the Virgin Islands and Puerto Rico), where spatial and genetic mixing among these groups occurs (Waring et al. 2015). While migrating, humpback whales utilize the mid-Atlantic as a migration pathway between calving/mating grounds to the south and feeding grounds in the north (Waring et al. 2007). Since 1989, observations of juvenile humpbacks in the Mid-Atlantic have been increasing during the winter months, peaking January through March (Swingle et al. 1993). Biologists theorize that non-reproductive animals may be establishing a winter feeding range in the Mid-Atlantic since they are not participating in reproductive behavior in the Caribbean. Swingle et al. (1993) identified a shift in distribution of juvenile humpback whales in the nearshore waters of Virginia, primarily in winter months.

Humpback whales were hunted as early as the seventeenth century, with most whaling operations having occurred in the nineteenth century (Kenney and Vigness-Raposa 2009). Before whaling activities, it was thought that the abundance of whales in the North Atlantic stock was in excess of 15,000 (Nowak 2002). By 1932, commercial hunting within the North Atlantic may have reduced the humpback whale population to as little as 700 individuals (Breiwick et al. 1983). Humpback whales were commercially exploited by whalers throughout their whole range until they were protected in the North Atlantic in 1955 by the International Whaling Commission (IWC) ban. Humpback whaling ended worldwide in 1966 (NatureServe 2010). Contemporary anthropogenic threats to humpback whales include fishery entanglements and vessel strikes. Glass et al. (2008) reported that between 2002 and 2006, humpback whales belonging to the Gulf of Maine population were involved in 77 confirmed entanglements with fishery equipment and nine confirmed ship strikes. Humpback whales that were entangled exhibited the highest number of serious injury events of the six species of whale studied by Glass et al. (2008). A whale mortality and serious injury

study conducted by Nelson et al. (2007) reported that the minimum annual rate of anthropogenic mortality and serious injury to humpback whales occupying the Gulf of Maine was 4.2 individuals per year. During this study period, humpback whales were involved in 70 reported entanglements and 12 vessel strikes, and were the most common dead species reported. This number has increased to 10.3 animals per year between 2008 and 2012 (Waring et al. 2015). The humpback whale population within the North Atlantic has been estimated to include approximately 11,570 individuals (Waring et al. 2015). Through photographic population estimates, humpback whales within the Gulf of Maine (the only region where these whales summer in the United States) have been estimated to consist of 600 individuals in 1979 (NMFS 1991b). According to the species stock assessment report, the best estimate of abundance for the Gulf of Maine stock of humpback whales is 847 individuals (Waring et al. 2015).

Humpbacks occur off southern New England in all four seasons, with peak abundance in spring and summer. The species is listed as Endangered due to the depletion of its population from whaling (NMFS 1991b). A recovery plan has been written and is currently in effect (NMFS 1991b).

Fin Whale (*Balaenoptera physalus*) – Endangered

The fin whale was listed as federally endangered in 1970. Fin whales' range in the North Atlantic extends from the Gulf of Mexico, Caribbean Sea, and Mediterranean Sea in the south to Greenland, Iceland, and Norway in the north (Jonsgård 1966; Gambell 1985a). They are the most commonly sighted large whales in continental shelf waters from the Mid-Atlantic coast of the United States to Nova Scotia (Sergeant 1977; Sutcliffe and Brodie 1977; CETAP 1982; Hain et al. 1992; Waring et al. 2008). Fin whales, much like humpback whales, seem to exhibit habitat fidelity (Waring et al. 2007; Kenney and Vigness-Raposa 2009). However, fin whales habitat use has shifted in the southern Gulf of Maine, most likely due to changes in the abundance of sand lance and herring, both of which are major prey species along with squid, krill, and copepods (Kenney and Vigness-Raposa 2009). While fin whales typically feed in the Gulf of Maine and the waters surrounding New England, mating and calving (and general wintering) areas are largely unknown (Waring et al. 2007). The overall pattern of fin whale movement is complex, consisting of a less obvious north-south pattern of migration than that of right and humpback whales. Based on acoustic recordings from hydrophone arrays, Clark (1995) reported a general southward flow pattern of fin whales in the fall from the Labrador/Newfoundland region, past Bermuda, and into the West Indies. The overall distribution may be based on prey availability, as this species preys opportunistically on both invertebrates and fish (Watkins et al. 1984). Fin whale abundance off the coast of the northeastern United States is highest between spring and fall, with some individuals remaining during the winter (Hain et al. 1992). A recent estimate of fin whale abundance conducted between Georges Bank and the Gulf of St. Lawrence during the feeding season in August 2006 places the western North Atlantic fin whale populations at 2,269 individuals (Waring et al. 2007). Fin whales are the second largest living whale species on the planet (Kenney and Vigness-Raposa 2009). The gestation period for fin whales is approximately 11 months and calve births occur between late fall and winter. Females can give birth every two to three years.

Present threats to fin whales are similar to other whale species, namely fishery entanglements and vessel strikes. Fin whales seem less likely to become entangled than other whale species. Glass et al. (2008) reported that between 2002 and 2006, fin whales belonging to the Gulf of Maine population were involved in only eight confirmed entanglements with fishery equipment. Furthermore, Nelson et al. (2007) reported that fin whales exhibited a low proportion of entanglements (eight reported events) during their 2001 to 2005 study along the western Atlantic. On the other hand, vessel strikes may be a more serious threat to fin whales. Eight and 10 confirmed vessel strikes with fin whales were reported by Glass et al. (2008) and Nelson et al. (2007), respectively. This level of incidence was similar to that exhibited by the other whales

studied. Conversely, a study compiling whale/vessel strike reports from historical accounts, recent whale strandings, and anecdotal records by Laist et al. (2001) reported that of the 11 great whale species studied, fin whales were involved in collisions most frequently (31 in the United States and 16 in France). From 2005 to 2009, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 2.6 per year (Waring et al. 2011) while from 2008 to 2012, this number has increased to 3.35 (Waring et al. 2015). Increase in ambient noise has also impacted fin whales, for whales in the Mediterranean have demonstrated at least two different avoidance strategies after being disturbed by tracking vessels (Jahoda et al. 2003). The best abundance estimate available for the western North Atlantic fin whale stock is 1,618 (Waring et al. 2015).

Fin whales are present in southern New England waters during all four seasons. In spring, summer, and fall, the main center of their distribution is in the Great South Channel area to the east of Cape Cod, which is a well-known feeding ground (Kenney and Winn 1986). Winter is the season of lowest overall abundance, but they do not depart the area entirely. Fin whales are the most common large whale encountered in continental shelf waters south of New England and into the Gulf of Maine. They are the whales most often encountered by local whale-watching operations in most years and are likely to occur in the Lease Area. The species is listed as Endangered due to the depletion of its population from whaling (Reeves et al. 1998). A recovery plan has been written and is available from the NMFS for review (Waring et al. 2010; 2011).

Minke Whale (*Balaenoptera acutorostrata*) – Non-Strategic

Minke whales are among the most widely distributed of all the baleen whales. They occur in the North Atlantic and North Pacific, from tropical to polar waters. Common minke whales range between 20 and 30 ft (6 and 9 m long) (with maximum lengths of 30 to 33 ft [9 to 10 m]) and are the smallest of the North Atlantic baleen whales (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The primary prey species for minke whales are most likely sand lance, clupeids, gadoids, and mackerel (Kenney and Vigness-Raposa 2009). These whales basically feed below the surface of the water, and calves are usually not seen in adult feeding areas. Minke whales are almost absent from OCS waters off the western Atlantic in winter; however, they are common in the fall and abundant in spring and summer (CeTAP 1982; Kenney and Vigness-Raposa 2009). The most recent estimate for minke whales in the Canadian East Coast stock is 20,741 (Waring et al. 2015). Minke whales have been observed in southern New England waters during all four seasons.

As is typical of the baleen whales, minke whales are usually seen either alone or in small groups, although large aggregations sometimes occur in feeding areas (Reeves et al. 2002). Minke populations are often segregated by sex, age, or reproductive condition. Known for their curiosity, minke whales often approach boats.

Minke whales are impacted by ship strikes and bycatch from bottom trawls, lobster trap/pot, gillnet, and purse seine fisheries. From 2005 to 2009, the minimum annual rate of mortality for the North Atlantic stock from anthropogenic causes was approximately 5.9 per year (Waring et al. 2011), while from 2008 to 2012 this increased to 9.9 per year (Waring et al. 2015). In addition, hunting for Minke whales continues today, by Norway in the northeastern North Atlantic and by Japan in the North Pacific and Antarctic (Reeves et al. 2002). International trade in the species is currently banned. The best recent abundance estimate for this stock is 8,987 (Waring et al. 2011). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2010; 2011; 2015).

4.3 Earless Seals (Phocidae)

Harbor Seal (*Phocac vitulina*) – Non-Strategic

Harbor seals are the most abundant seals in eastern United States waters and are commonly found in all nearshore waters of the Atlantic Ocean and adjoining seas above northern Florida; however, their "normal" range is probably only south to New Jersey. While harbor seals occur year-round north of Cape Cod, they only occur during winter migration, typically September through May, south of Cape Cod (Southern New England to New Jersey) (Waring et al. 2015; Kenney and Vigness-Raposa 2009). During the summer, most harbor seals can be found north of New York, within the coastal waters of central and northern Maine, as well as the Bay of Fundy (DoN 2005). Harbor seals are relatively small pinnipeds, with adults ranging between 1.7 and 1.9 m in length, with females being slightly smaller than males (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009).

Harbor seals prey upon small to medium-sized fish, followed by octopus and squid, and lastly by shrimp and crabs (Kenney and Vigness-Raposa 2009). Fish eaten by harbor seals include commercially important species such as mackerel, herring, cod, hake, smelt, shad, sardines, anchovy, capelin, salmon, rockfish, sculpins, sand lance, trout, and flounders (Kenney and Vigness-Raposa 2009). They spend about 85 percent of the day diving, and much of the diving is presumed to be active foraging in the water column or on the seabed. They dive to depths of about 30 to 500 feet (10 to 150 meters), depending on location. Harbor seals forage in a variety of marine habitats, including deep fjords, coastal lagoons and estuaries, and high-energy, rocky coastal areas. They may also forage at the mouths of freshwater rivers and streams, occasionally traveling several hundred miles upstream (Reeves et al. 2002). They haul out on sandy and pebble beaches, intertidal rocks and ledges, and sandbars, and occasionally on ice floes in bays near calving glaciers.

Except for a strong bond between mothers and pups, harbor seals are generally intolerant of close contact with other seals. Nonetheless, they are gregarious, especially during the molting season, which occurs between spring and autumn, depending on geographic location. They may haul out to molt at a tide bar, sandy or cobble beach, or exposed intertidal reef. During this haulout period, they spend most of their time sleeping, scratching, yawning, and scanning for potential predators such as humans, foxes, coyotes, bears, and raptors (Reeves et al. 2002). In late autumn and winter, harbor seals may be at sea continuously for several weeks or more, presumably feeding to recover body mass lost during the reproductive and molting seasons and to fatten up for the next breeding season (Reeves et al. 2002).

Historically, these seals have been hunted for several hundred to several thousand years. Harbor seals are still killed legally in Canada, Norway, and the United Kingdom to protect fish farms or local fisheries (Reeves et al. 2002). From 2006 to 2010, the average rate of mortality for the Western North Atlantic harbor seal stock from anthropogenic causes was approximately 337 per year (Waring et al. 2013). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as "non-strategic" (Waring et al. 2013).

Gray Seal (*Halichoerus grypus*) – Non-Strategic

The gray seal occurs in cold temperate to sub-arctic waters in the North Atlantic, and is partitioned into three major populations occurring in eastern Canada, northwestern Europe, and the Baltic Sea (Jefferson et al. 2008; Kenney and Vigness-Raposa 2009). The western North Atlantic stock is considered to be the same population as the one found in eastern Canada, and ranges between New England and Labrador (Waring et al. 2007). As exhibited in harbor seal populations, gray seals occur most often in the waters off of Maine during winter and spring, and spend summer and fall off northern Maine and in Canadian waters

(DoN 2005). Gray seals exhibit sexual dimorphism, with adult males reaching 2.3 m long and females reaching 2.0 m (Jefferson et al. 1993; Wynne and Schwartz 1999; Kenney and Vigness-Raposa 2009). The gray seal is primarily found in coastal waters and forages in OCS regions (Lesage and Hammill 2001).

Gray seals are gregarious, gathering to breed, molt, and rest in groups of several hundred or more at island coasts and beaches or on land-fast ice and pack-ice floes. They are thought to be solitary when feeding and telemetry data indicates that some seals may forage seasonally in waters close to colonies, while others may migrate long distances from their breeding areas to feed in pelagic waters between the breeding and molting seasons (Reeves et al. 2002). Gray seals molt in late spring or early summer and may spend several weeks ashore during this time. When feeding, most seals remain within 45 miles (72 km) of their haulout sites. Gray seals feed on numerous fish species and cephalopods (Kenney and Vigness-Raposa 2009). Gray seal scat samples from Muskeget Island, Massachusetts, included species such as sand lance, skates, flounder, silver hake, and gadids (Kenney and Vigness-Raposa 2009).

Gray seals form colonies on rocky island or mainland beaches, though some seals give birth in sea caves or on sea ice, especially in the Baltic Sea. Gray seals prefer haulout and breeding sites that are surrounded by rough seas and riptides where boating is hazardous. Pupping colonies have been identified at Muskegat Island (Nantucket Sound), Monomoy National Wildlife Refuge, and in eastern Maine (Rough 1995). The gray seal colony of Massachusetts has more than 5,600 seals total and there are more than 1,700 individuals in Maine (Waring et al. 2007). This species has been reported with greater frequency in waters south of Cape Cod in recent years, likely due to a population rebound in southern New England and the mid-Atlantic (Kenney and Vigness-Raposa 2009); however, most gray seals present are juveniles dispersing in the spring. The only consistent haul-out locations within the vicinity of the Lease Area are along the sandy shoals around Monomoy and Nantucket in Massachusetts (Kenney and Vigness-Raposa 2009).

The biggest threats to gray seals are entanglements in gillnets or plastic debris (Waring et al. 2004). The total estimated human-caused mortality from 2006 to 2010 to gray seals was approximately 5,253 per year, which includes the removal of nuisance animals in Canada (Waring et al. 2015). Average annual fishery-related mortality and serious injury does not exceed the potential biological removal for this species; therefore, NMFS considers this species as “non-strategic” (Waring et al. 2015).

5. Type of Incidental Taking Requested

The Applicant is requesting the authorization for potential non-lethal “taking” of small numbers of marine mammals to allow for incidental harassment resulting from the marine site characterization surveys. The request is based upon projected DP vessel thruster use during the anticipated survey schedule as stated in Section 2.1.

The results of the underwater acoustic modeling as depicted in Table 1-3 are consistent with DP vessels. As evidenced in Table 1-3, sound levels associated with Level A harassment will not occur. Survey activities could; however, result in temporary Level B harassment of marine mammals during use of DP drill ship thruster use.

To ensure that the potential for take by Level B harassment is avoided and/or minimized to the maximum extent possible, the Applicant has committed to the mitigation measures as outlined in Sections 11.0 and 13.0, which have been successfully implemented during similar activities in the North Atlantic.

5.1 Bay State Wind Marine Site Characterization Survey Activities

As detailed in Section 1.2, DP thruster use would generate underwater noise with sounds exceeding the 120 dB_{RMS} re 1 µPa threshold for Level B harassment for continuous sound. The Applicant is requesting the authorization for the incidental take by harassment, of small numbers of marine mammals in the waters of southern New England pursuant to Section 101 (a) (5) of the MMPA and in accordance with 50 CFR § 216 Subpart I, in support of the Applicant's survey activities. The following two species are requested to be approved for take by Level B Harassment for DP thruster use in support of geotechnical surveys in the fall of 2016:

- Atlantic white-sided dolphin (*Lagenorhynchus acutus*)
- Short beaked common dolphin (*Delphinus delphis*)

Take calculations detailed in Section 6 indicate that numbers for North Atlantic right whale (*Eubalaena glacialis*), humpback whale (*Megaptera novaeangliae*), Fin whale (*Balaenoptera physalus*), Minke whale (*B. acutorostrata*), Harbor porpoise (*Phocoena phocoena*), Harbor seal (*Phoca vitulina*), and Gray seal (*Halichoerus grypus*) approach zero; therefore, no take for these species is requested.

6. Take Estimates for Marine Mammals

The Applicant seeks authorization for potential "taking" of small numbers of marine mammals under the jurisdiction of the NMFS in the proposed region of activity. Species for which authorization is sought include the common and Atlantic white-sided dolphins. These two species, described in detail in Section 4.0, have the highest likelihood of occurring, at least occasionally, in the Lease Area during the proposed survey events.

The only anticipated impacts to marine mammals that are associated with noise propagation from the use of the drill ship DP thrusters.

It should be noted that the estimates of take for marine mammals as presented in this section are conservative and based on worse-case assumptions.

6.1 Basis for Estimating Numbers of Marine Mammals that Might be "Taken by Harassment"

Most marine animals can perceive underwater sounds over a broad range of frequencies from about 10 hertz (Hz) to more than 10,000 Hz (10 kilohertz [kHz]). Many of the dolphins and porpoises use even higher frequency sound for echolocation and perceive these high frequency sounds with high acuity. Marine mammals respond to low-frequency sounds with broadband intensities of more than about 120 dB re 1 µPa, or about 10 to 20 dB above natural ambient noise at the same frequencies (Richardson et al. 1991). The functional hearing ranges for the 10 marine mammals having the highest likelihood of occurring in the Lease Area at the time of the proposed surveys are provided in Table 6-1.

Table 6-1 Functional Hearing Range of Marine Mammals with the Potential to Occur within Lease Area

Species	Estimated Auditory Bandwidth[1]
North Atlantic Right Whale	50 to 600 Hz2
Humpback Whale	7 Hz to 22 kHz
Fin Whale	7 Hz to 22 kHz
Minke Whale	7 Hz to 22 kHz
Sperm Whale	150 Hz to 160 kHz
Short-Beaked Common Dolphin	150 Hz to 160 kHz
Atlantic White-Sided Dolphin	150 Hz to 160 kHz
Harbor Porpoise	200 Hz to 180 kHz
Short-Beaked Common Dolphin	150 Hz to 160 kHz
Harbor Seal	75 Hz to 75 kHz
Gray Seal	75 Hz to 75 kHz

[1]Southall et al. (2007)
[2]Vanderlaan et al. (2003); and Park et al. (2010)

Sound is important to marine mammals for communication, individual recognition, predator avoidance, prey capture, orientation, navigation, mate selection, and mother-offspring bonding. Potential effects of anthropogenic sounds to marine mammals can include physical injury (e.g., temporary or permanent loss of hearing sensitivity), behavioral modification (e.g., changes in foraging or habitat-use patterns), and masking (the prevention of marine mammals from hearing important sounds).

The only survey activities that have the potential to cause harassment as defined by the MMPA include the noise produced by the drill ship DP thrusters (120 dB_{RMS} re 1 µPa). As stated previously, the Applicant conducted a hydroacoustic modeling assessment of the potential drill ship DP thruster use to better understand both the level and extent of underwater noise generated during survey activities and their potential to impact marine species. The results of the underwater acoustic modeling assessment are summarized in Section 1.2 and Table 1-3. The assessments are included in Appendix A.

The basis for the take estimate is the number of marine mammals that would be exposed to sound levels in excess of Level B harassment criteria (120 dB_{RMS} re 1 µPa). Typically this is determined by multiplying the ZOI out to the Level B harassment criteria isopleth by local marine mammal density estimates, and then correcting for seasonal use by marine mammals, seasonal duration of project-specific noise-generating activities, and estimated duration of individual activities when the maximum noise-generating activities are intermittent or occasional. In the absence of any part of this information, it becomes prudent to take a conservative approach to ensure the potential number of takes is not greatly underestimated.

Acoustic modeling of the DP drill ship was completed based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) and BELLHOP Gaussian beam ray-trace propagation model (Porter and Liu 1994). BELLHOP and RAM are widely used by sound engineers and marine biologists due to its adaptability to describe highly complex acoustic scenarios. RAM is based on the parabolic equation (Collins 1993) method using the split-step Padé algorithm for improved numerical accuracy and efficiency in solving range dependent acoustic problems and has been extensively benchmarked (Collins et al. 1996). The BELLHOP algorithm is based on a beam-tracing methodology and provides better accuracy by accounting for increased sound attenuation due to volume absorption at higher frequencies and allowing for source directivity components. The modeling methodologies employed calculate transmission loss based on a number of factors including the distance between the source and receiver along with basic ocean sound propagation parameters (e.g., depths, bathymetry, sediment type,

and seasonal sound speed profiles). For each sound source, modeling was performed along transects originating out from the source along compass points (45°, 90°, 135°, 180°, 225°, 270°, 315°, and 360°) and propagated horizontally. The received sound field within each radial plane was then sampled at various ranges and depths from the source with fixed steps. The received sound level at a given location along a given transect was then taken as the maximum value that would occur over all samples within the water column. These values are then summed across frequencies to provide broadband received levels at the MMPA Level A and B harassment criteria as described in Table 1-3. The representative area ensonified to the MMPA Level B threshold for DP thruster use was used to estimate take. The maximum critical distances to the MMPA threshold was used to support the development of the monitoring and/or mitigation programs (see Sections 11.0).

As stated previously, the NMFS Level B harassment criterion for continuous noise is 120 dB_{RMS} re 1 µPa. For DP thruster use, the ensonified area at the 120 dB_{RMS} re 1 µPa isopleth was modeled at three representative water depths (125 ft, 144 ft, and 177 ft [38 m, 44 m, and 54 m]) within the Lease Area. Because the vessel will be stationary during the geotechnical activities, the maximum ZOI for the drill ship thrusters has been conservatively estimated to be approximately 9.8 mi^2 (25.4 km^2). This ZOI also represents the worst-case ensonified area across the three representative water depths within the Lease Area. As shown in Table 1-3, DP thrusters will not produce sound levels at 180 dB_{RMS} re 1 µPa.

6.2 Estimate of Numbers of Marine Mammals that Might be "Taken by Harassment"

Estimates of take are computed according to the following formula as provided by NOAA (Personal Communication, November 24, 2015):

Estimated Take = D x ZOI x (d)

Where:

D = average highest species density (number per 100 km^2)
ZOI = maximum ensonified area to MMPA thresholds for continuous noise (120 dB_{RMS} re 1 µPa)
d = number of days

The data used as the basis for estimating species density for the Lease Area are sightings per unit effort (SPUE) taken from Kenney and Vigness-Raposa (2009). SPUE (or, the relative abundance of species) is derived by using a measure of survey effort and number of individual cetaceans sighted. SPUE allows for comparison between discrete units of time (i.e. seasons) and space within a project area (Shoop and Kenney, 1992). SPUE calculated by Kenney and Vigness-Raposa (2009) was derived from a number of sources including: 1) North Atlantic Right Whale Consortium database; 2) CeTAP (CeTAP 1982); 3) sightings data from the Coastal Research and Education Society of Long Island, Inc. and Okeanos Ocean Research Foundation; 4) the Northeast Regional Stranding network (marine mammals); and 5) the NMFS Sampling Branch (Woods Hole, MA).

The Northeast Navy Operations Area (OPAREA) Density Estimates (DoN 2007) were also used in support for estimating take for seals, which represents the only available comprehensive data for seal abundance. However, abundance estimates for the Southern New England area includes breeding populations on Cape Cod, and therefore using this dataset alone will result in a substantial over-estimate of take in the Project Area. However, based on reports conducted by Kenney and Vigness-Raposa (2009), Schroeder (2000), and Ronald and Gots (2003), harbor seal abundance off the Southern New England coast in the vicinity of the survey is likely to be approximately 20 percent of the total abundance. In addition, because the seasonality of, and habitat use by, gray seals roughly overlaps with harbor seals, the same abundance

assumption of 20 percent of the southern New England population of gray seals can be applied when estimating abundance. Per this data, take due to Level B harassment for harbor seals and gray seals have been calculated based on 20 percent of the Northeast Navy OPAREA Density Estimates.

Due to the spatial distribution and transient nature of marine mammal species identified; the relatively short duration of the activities and the time of year the Applicant proposes to conduct marine characterization survey activities; and the implementation of the mitigation measures as described in Section 11.0, these activities are not likely result in serious injury or death. In addition, the take estimates as provided in Section 6.2.1 do not take into consideration mitigation measures and therefore are likely an overestimate of the actual potential for take by Level B acoustic harassment.

6.2.1 Estimate of Potential DP Thrusters Takes by Harassment

Estimates of DP vessel thruster use during geotechnical survey activities have been based on a maximum ZOI of 9.8 mi^2 (25.4 km^2). As detailed in Section 6.1, this ZOI represents the worst-case ensonified area across the three representative water depths within the Lease Area (125 ft, 144 ft, and 177 ft [38 m, 44 m, and 54 m]). DP thruster use is expected to take place for a period of approximately 6 days. Based on the proposed geotechnical survey schedule (September 2016), take calculations were based on the fall seasonal species density. The resulting take estimates (rounded to the nearest whole number) based upon these conservative assumptions for the common and Atlantic white-sided dolphins and harbor seals are presented in Table 6-2. These numbers are based on 6 days and represent a maximum of 0.010 and 0.023 percent of populations for these species, respectively. These percentages are the upper boundary of the animal population that could be affected. These take numbers are based on an assumption that no mitigation will be applied during geotechnical survey activities, which will not be the case. Mitigation and monitoring of potential take during geotechnical survey activities is detailed in Section 11.0. It is expected, that with the application of the proposed mitigation and monitoring measures, the take of marine mammals as presented in Table 6-2 will be significantly reduced.

Table 6-2 Marine Mammal Density and Estimated Level B Harassment Take Numbers during DP Thruster Activities

Species	Density for Fall (No./100 km^2)	Calculated Take (No.)	Requested Take Authorization (No.)
North Atlantic Right Whale	0.07	0.10	0
Humpback Whale	0.05	0.07	0
Fin Whale	0.14	0.21	0
Minke Whale	0.44	0.68	0
Common Dolphins	8.21	12.50	13
Atlantic White-sided Dolphin	7.46	11.35	11
Harbor Porpoise	0.23	0.35	0
Harbor Seal[1]	9.74	0.30	0
Gray Seal[1]	14.16	0.43	0

[1] Density values were derived using 20 percent of the number estimated from DoN (2007) density values.

7. Anticipated Impacts of the Activity

Consideration of negligible impact is required for the NMFS to authorize the incidental take of marine mammals. In 50 CFR § 216.103, the NMFS defines negligible impact to be “an impact resulting from a specified activity that cannot be reasonably expected to, and is not reasonably likely to, adversely affect

the species or stocks [of marine mammals] through effects on annual rates of recruitment or survival." Based upon best available data regarding the marine mammal species (including density, status, and distribution) that are likely to occur in the Lease Area, the Applicant concludes that exposure to marine mammal species and stocks during marine site characterization surveys would result in short-term minimal effects and would not affect the overall annual recruitment or survival for the following reasons:

- As detailed in Section 1.2 and Appendix A, potential acoustic exposures from DP thruster use is within the non-injurious behavioral effects zone (Level B harassment);
- The potential for take as estimated in Section 6.2.1 represents conservative estimates of harassment based upon typical DP vessel operation scenarios without taking into consideration the effects of standard mitigation and monitoring measures; and
- The protective measures as described in Section 11.0 are designed to avoid and/or minimize the potential for interactions with and exposure to marine mammals.

Marine mammals are mobile free-ranging animals and have the capacity to exit an area when noise-producing survey activities are initiated. Based on our take estimations, DP thruster use may disturb more than one individual for some species (mainly dolphins), but in conjunction with other aforementioned factors we conclude the short-term vessel activities are not expected to result in population-level effects and that individuals will return to normal behavioral patterns after activities have ceased or after the animal has left the area under survey.

8. Anticipated Impacts on Subsistence Uses on Subsistence Uses

There are no traditional subsistence hunting areas in the Lease Area.

9. Anticipated Impacts on Habitat

Bottom disturbance associated with the geotechnical survey program will consist of the 4 deep bore holes of approximately 3 to 4 inches (in; 7.6 to 10.1 centimeters [cm]) diameter, the 15 shallow CPTs of up to approximately 1 in (2.5 cm) in diameter, and the 4 deep CPTs approximately 1 in (2.5 cm) in diameter.

Impact on marine mammal habitat from these activities will be insignificant and discountable.

10. Anticipated Effects of Habitat Impacts on Marine Mammals

As stated in Section 9.0, the effects to marine mammals from loss or modification of habitat from the proposed survey activities will be insignificant and discountable.

11. Mitigation Measures

The Applicant commits to engaging in ongoing consultations with NMFS. Per the Lease, the Applicant has committed the following comprehensive set of mitigation measures during marine site characterization surveys. The mitigation procedures outlined in this section are based on protocols and procedures that have been successfully implemented in similar offshore projects and previously approved by NMFS.

11.1 Vessel Strike Avoidance Procedures

The Applicant will ensure that vessel operators and crew maintain a vigilant watch for cetaceans, pinnipeds, and sea turtles and slow down or stop their vessels to avoid striking these protected species. Survey vessel

crew members responsible for navigation duties will receive site-specific training on marine mammal and sea turtle sighting/reporting and vessel strike avoidance measures. Vessel strike avoidance measures will include the following, except under extraordinary circumstances when complying with these requirements would put the safety of the vessel or crew at risk:

- All vessel operators will comply with 10 knot (<18.5 km per hour [km/h]) speed restrictions in any Dynamic Management Area (DMA). In addition, all vessels operating from November 1 through July 31 will operate at speeds of 10 knots (<18.5 km/h) or less.
- All survey vessels will maintain a separation distance of 500 m or greater from any sighted North Atlantic right whale.
- If underway, vessels must steer a course away from any sited North Atlantic right whale at 10 knots (<18.5 km/h) or less until the 500 m minimum separation distance has been established. If a North Atlantic right whale is sited in a vessel's path, or within 100 m to an underway vessel, the underway vessel must reduce speed and shift the engine to neutral. Engines will not be engaged until the North Atlantic right whale has moved outside of the vessel's path and beyond 100 m. If stationary, the vessel must not engage engines until the North Atlantic right whale has moved beyond 100 m.
- All vessels will maintain a separation distance of 100 m or greater from any sighted non-delphinoid cetacean. If sighted, the vessel underway must reduce speed and shift the engine to neutral, and must not engage the engines until the non-delphinoid cetacean has moved outside of the vessel's path and beyond 100 m. If a survey vessel is stationary, the vessel will not engage engines until the non-delphinoid cetacean has moved out of the vessel's path and beyond 100 m.
- All vessels will maintain a separation distance of 50 m or greater from any sighted delphinoid cetacean. Any vessel underway remain parallel to a sighted delphinoid cetacean's course whenever possible, and avoid excessive speed or abrupt changes in direction. Any vessel underway reduces vessel speed to 10 knots or less when pods (including mother/calf pairs) or large assemblages of delphinoid cetaceans are observed. Vessels may not adjust course and speed until the delphinoid cetaceans have moved beyond 50 m and/or the abeam of the underway vessel.
- All vessels will maintain a separation distance of 50 m (164 ft) or greater from any sighted sea turtle or pinniped.

The training program will be provided to NMFS for review and approval prior to the start of surveys. Confirmation of the training and understanding of the requirements will be documented on a training course log sheet. Signing the log sheet will certify that the crew members understand and will comply with the necessary requirements throughout the survey event.

11.2 Seasonal Operating Requirements

Between watch shifts members of the monitoring team will consult the NMFS North Atlantic right whale reporting systems for the presence of North Atlantic right whales throughout survey operations. The proposed survey activities will, however, occur outside of the seasonal management area (SMA) located off the coast of Massachusetts and Rhode Island. The proposed survey activities will also occur in September, which is outside of the seasonal mandatory speed restriction period for this SMA (November 1 through April 30).

Throughout all survey operations, the Applicant will monitor the NMFS North Atlantic right whale reporting systems for the establishment of a DMA. If NMFS should establish a DMA in the Lease Area under survey, within 24 hours of the establishment of the DMN the Applicant will work with NMFS to shut down and/or altered the survey activities to avoid the DMA.

11.3 Visual Monitoring Program

Per the results of the hydroacoustic modeling assessment, the Applicant proposes to employ a 3,500-m monitoring zone during the use of DP thrusters. A monitoring zone is an area established for the Protected Species Observers (PSOs) to monitor for the presence of marine mammals. Its radial distance from the sound source (DP drill ship) is derived from the hydroacoustic modeling and covers the area associated with Level B acoustic harassment. Visual monitoring of the established monitoring zone will be performed by qualified and NMFS-approved PSOs. Observer qualifications will include direct field experience on a marine mammal/sea turtle observation vessel and/or aerial surveys in the Atlantic Ocean/Gulf of Mexico. An observer team comprising a minimum of four NMFS-approved PSOs and two certified Passive Acoustic Monitoring (PAM) operators, operating in shifts, will be stationed aboard either the survey vessel or a dedicated PSO-vessel. PSOs and PAM operators will work in shifts such that no one monitor will work more than 4 consecutive hours without a 2 hour break or longer than 12 hours during any 24-hour period. Each PSO will monitor 360 degrees of the field of vision. The Applicant will provide resumes of all proposed PSOs and PAM operators (including alternates) to BOEM for review and approval by NMFS at least 45 days prior to the start of survey operations.

The PSOs will begin observation of the monitoring zone during all geotechnical operations where DP thrusters are employed. Observations of the monitoring zone will continue throughout the survey activity and/or while DP thrusters are in use. PSOs will be responsible for visually monitoring and identifying marine mammals approaching or entering the established monitoring zone during survey activities. It will be the responsibility of the Lead PSO on duty to communicate the presence of marine mammals as well as to communicate and enforce the action(s) that are necessary to ensure mitigation and monitoring requirements are implemented as appropriate. PAM operators will communicate detected vocalizations to the Lead PSO on duty, who will then be responsible for implementing the necessary mitigation procedures. A mitigation and monitoring communications flow diagram has been included as Appendix B.

PSOs will be equipped with binoculars and have the ability to estimate distances to marine mammals located in proximity to the vessel and/or monitoring zone using range finders. Reticulated binoculars will also be available to PSOs for use as appropriate based on conditions and visibility to support the siting and monitoring of marine species. Digital single-lens reflex camera equipment will be used to record sightings and verify species identification. During night operations, PAM, night-vision equipment, and infrared technology will be used. Position data will be recorded using hand-held or vessel global positioning system (GPS) units for each sighting.

Observations will take place from the highest available vantage point on the survey vessel. General 360-degree scanning will occur during the monitoring periods, and target scanning by the PSO will occur when alerted of a marine mammal presence.

Data on all PAM/PSO observations will be recorded based on standard PSO collection requirements. This will include dates and locations of construction operations; time of observation, location and weather; details of the sightings (e.g., species, age classification [if known], numbers, behavior); and details of any observed “taking” (behavioral disturbances or injury/mortality). The data sheet will be provided to both NMFS and BOEM for review and approval prior to the start of survey activities. In addition, prior to initiation of survey work, all crew members will undergo environmental training, a component of which will focus on the procedures for sighting and protection of marine mammals and sea turtles. A briefing will also be conducted between the survey supervisors and crews, the PSOs, and the Applicant. The purpose of the briefing will

be to establish responsibilities of each party, define the chains of command, discuss communication procedures, provide an overview of monitoring purposes, and review operational procedures.

11.4 Passive Acoustic Monitoring Program

To support 24-hour survey operations, the Applicant will include PAM as part of the project monitoring during the geotechnical survey program during nighttime operations to provide for optimal acquisition of species detections at night.

Given the range of species that could occur in the Lease Area, the PAM system will consist of an array of hydrophones with both broadband (sampling mid-range frequencies of 2 kHz to 200 kHz) and at least one low-frequency hydrophone (sampling range frequencies of 75 Hz to 30 kHz).

The PAM operator(s) will monitor the hydrophone signals in real time both aurally (using headphones) and visually (via the monitor screen displays). PAM operators will communicate detections to the Lead PSO on duty who will ensure the implementation of the appropriate mitigation measure.

11.5 Ramp-Up Procedures

The DP vessel thrusters will be engaged to support the safe operation of the vessel and crew while conducting geotechnical survey activities and require use as necessary. Therefore, there is no opportunity to engage in a ramp-up procedure.

11.6 Shut-Down and Power-Down Procedures

During geotechnical survey activities, a constant position over the drill, coring or CPT site must be maintained to ensure the integrity of the survey equipment. Any stoppage of DP vessel thruster during the proposed geotechnical activities has the potential to result in significant damage to survey equipment. Therefore, during geotechnical survey activities if marine mammals enter or approach the established 120 dB isopleth monitoring zone, the Applicant proposes to reduce DP thruster to the maximum extent possible, except under circumstances when reducing DP thruster use would compromise safety (both human health and environmental) and/or the integrity of the equipment. Reducing thruster energy will effectively reduce the potential for exposure of marine mammals and sea turtles to sound energy. After decreasing thruster energy, PSOs will continue to monitor marine mammal and/or sea turtle behavior and determine if the animal(s) is moving towards or away from the established monitoring zone. If the animal(s) continues to move towards the sound source then DP thruster use would remain at the reduced level. Normal use will resume when PSOs report that the marine mammals have moved away from and remained clear of the monitoring zone for a minimum of 60 minutes since last the sighting.

12. Arctic Plan of Cooperation

Potential impacts to species or stocks of marine mammals will be limited to individuals of marine mammal species located in the northeast region of the United States, and will not affect Arctic marine mammals. Given that the Project is not located in Arctic waters, the activities associated with the Applicant's marine characterization surveys will not have an adverse effect on the availability of marine mammals for subsistence uses allowable under the MMPA.

13. Monitoring and Reporting

13.1 Monitoring

Field verification of the exclusion zones will be conducted to determine whether the proposed zones are adequate to minimize impacts to marine mammals. The details of the field verification strategy will be provided in a Field Verification Plan no later than 45 days prior to the commencement of field verification activities.

13.2 Reporting

The Applicant will provide the following reports as necessary during construction activities:

- The Applicant will contact BOEM and NMFS within 24 hours of the commencement of survey activities and again within 24 hours of the completion of the activity.
- Any observed significant behavioral reactions (e.g., animals departing the area) or injury or mortality to any marine mammals or sea turtles must be reported to BOEM and NMFS within 24 hours of observation. Dead or injured protected species (e.g., marine mammals, sea turtles and sturgeon) are reported to the NMFS Northeast Region's Stranding Hotline (800-900-3622) within 24 hours of sighting, regardless of whether the injury is caused by a vessel. In addition, if the injury of death was caused by a collision with a project related vessel, the Applicant must ensure that BOEM and NMFS are notified of the strike within 24 hours. The Applicant must use the form included as Appendix A to Addendum C of the Lease to report the sighting or incident. If The Applicant is responsible or the injury or death, the vessel must assist with any salvage effort as requested by NMFS.
- Within 90 days after completion of the marine site characterization survey activities, a final technical report will be provided to BOEM, and NMFS that fully documents the methods and monitoring protocols, summarizes the data recorded during monitoring, estimates the number of listed marine mammals and sea turtles that may have been taken during survey activities, and provides an interpretation of the results and effectiveness of all monitoring tasks.

In addition to the the Applicant's reporting requirements outlined above, the Applicant will provide an assessment report of the effectiveness of the various mitigation techniques, i.e. visual observations during day and night, compared to the PAM detections/operations. This will be submitted as draft to BOEM 30 days after the completion of survey activities and as a final version 60 days after completion of the survey.

14. Suggested Means of Coordination Research

All marine mammal data collected by the Applicant during marine characterization survey activities will be provided to NMFS, BOEM, and other interested government agencies, and be made available upon request to educational institutions and environmental groups. These organizations could use the data collected during this period to study ways to reduce incidental taking and evaluate its effects.

15. List of Preparers

Jennifer Daniels
Tetra Tech, Inc.
Environmental Scientist, Project Manager

Timothy Feehan
Tetra Tech, Inc.
Environmental Scientist

Kristjan Varnik
Tetra Tech, Inc.
Acoustic Engineer

Ann Zoidis
Tetra Tech, Inc.
Senior Environmental Scientist

16. References

ACSonline (American Cetacean Society). 2004. “Cetacean Fact Pack.” Site visited February 12, 2005. http://www.ACSonline.org/factpack/index.html

Baumgartner, M.F., and B.R. Mate. 2005. Summer and fall habitat of North Atlantic right whales (Eubalaena glacialis) inferred from satellite telemetry. Canadian Journal of Fisheries and Aquatic Sciences 62:527-543.

Blaylock, R.A., J.W. Hain, L.J. Hansen, D.L. Palka, and G.T. Waring. 1995. U.S. Atlantic and gulf of Mexico Marine Mammal Stock Assessments. NOAA Technical Memorandum NMFS-SEFSC-363.

Breiwick, J.M., E. Mitchell and R.R. Reeves. 1983. Simulated population trajectories for northwest Atlantic humpback whales, 1865-1980. In Abstracts of the Fifth Biennial Conference on the Biology of Marine Mammals, Boston, MA.

Bulloch, D.K. 1993. The Whale-Watcher’s Handbook, A Field Guide to the Whales, Dolphins, and Porpoises of North America.

CETAP. 1982. A characterization of marine mammals and turtles in the mid- and north Atlantic areas of the U.S. outer continental shelf. Cetacean and Turtle Assessment Program, University of Rhode Island. Final Report #AA551-CT8-48 to the Bureau of Land Management, Washington, DC, 538 pp.

Clark, C.W. 1995. Application of U.S. Navy underwater hydrophone arrays for scientific research on whales. Reports of the International Whaling Commission 45: 210-212.

Collins, M.D. 1993. The split-step Padé solution for the parabolic equation method. The Journal of the Acoustical Society of America 93:1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S.A. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. Journal of the Acoustical Society of America 100:178-182.

DoN (Department of the Navy). 2005. Marine Resources Assessment for the Northeast Operating Areas: Atlantic City, Narragansett Bay, and Boston. Final Report. Contract Number N62470-02-D-9997, CTO 0018. Department of the Navy, US Fleet Forces Command, Norfolk, VA. Prepared by Geo-Marine, Inc., Newport News, VA. xvi + 535 pp.

DoN. 2007. Navy OPAREA Density Estimates (NODE) for the Northeast OPAREAs: Boston, Naragansett Bay, and Atlantic City. Final report. Contract number N62470-02- D-9997, CTO 0045. Norfolk, Virginia: Atlantic Division, Naval Facilities Engineering Command. Prepared by Geo-Marine, Inc., Plano, Texas.

DoN. 2012. Final Marine Mammal Monitoring Plan Trident Support Facilities Explosives Handling Wharf (EHW-2). Naval Base Kitsap at Bangor Silverdale, WA. Available at: http://www.nmfs.noaa.gov/pr/pdfs/permits/kitsap_wharfconstruction_monitoring.pdf

Gambell, R. 1985. Fin whale *Balaenoptera physalus* (Linnaeus, 1758). Pp. 171B192 in S.H. Ridgway and R. Harrison (eds.), Handbook of marine mammals, Vol. 3. Academic Press, London.

Glass, A.H., T.V.N Cole, M. Garron, R.L. Merrick, and R.M. Pace III. 2008. Mortality and serious injury determinations for baleen whale stocks along the United States eastern seaboard and adjacent Canadian Maritimes, 2002-2006. U.S. Department of Commerce, Northeast Fisheries Science Center Ref Doc. 08-04; 18 p. Available from: National Marine Fisheries Service, 166 Water Street, Woods Hole, MA 02543-1026.

Hain, J.H.W., M.J. Ratnaswamy, R.D. Kenney, and H.E. Winn. 1992. The fin whale, Balaenoptera physalus, in waters of the northeastern United States continental shelf. Rep. Int. Whal. Commn 42:653B669.

IUCN (The World Conservation Union). 2010. 2010 IUCN Red List of Threatened Species. Available at: http://www.iucnredlist.org (Accessed in February 2010).

Jahoda, M., Lafortuna, C.L., Biassoni, N., Almirante, C., Azzellino, A., Panigada, S., Zanardelli, M. & Notarbartolo di Sciara, G. (2003) Mediterranean fin whale's (Balaenoptera physalus) response to small vessel and biopsy sampling assessed through passive tracking and timing of respiration. Marine Mammal Science, 19, 96–110.

Jefferson, T.A., S. Leatherwood, and M.A. Webber. 1993. FAO Species Identification Guide; Marine Mammals of the World. United Nations Environment Programme, Food and Agriculture Organization of the United Nations, Rome. viii + 320 pp.

Jefferson, T.A., M.A. Webber, and R.L. Pitman. 2008. Marine mammals of the world: A comprehensive guide to their identification. Amsterdam: Elsevier. 573 pp. London, UK: Elsevier.

Jensen, A.S., and G.K. Silber. 2004. Large Whale Ship Strike Database. U.S. Department of Commerce, NOAA Technical Memorandum. NMFS-OPR-, 37 pp.

Jonsgård, Å. 1966. Biology of the North Atlantic fin whale Balaenoptera physalus (L): taxonomy, distribution, migration and food. Hvalrådets Skrifter 49:1B62.

Kenney, R.D. 1990. Bottlenose dolphins off the northeastern United States. Pp. 369–396 in: S. Leatherwood and R. R. Reeves, eds. The Bottlenose Dolphin. Academic Press, San Diego, CA.

Kenney, R.D. 2002. North Atlantic, North Pacific and Southern Right Whales. pp. 806-813, In: W.F. Perrin, B. Würsig, and J.G.M. Thewissen (eds.). Encyclopedia of Marine Mammals. Academic Press, San Diego, CA.

Kenney, R.D., and K.J. Vigness-Raposa. 2009. Marine Mammals and Sea Turtles of Narragansett Bay, Block Island Sound,Rhode Island Sound, and Nearby Waters: An Analysis of Existing Data for the Rhode Island Ocean Special Area Management Plan. Technical Report, May 31, 2009.

Kenney, R.D. and H.E. Winn. 1986. Cetacean high-use habitats of the northeast United States continental shelf. Fishery Bulletin 84(2): 345-357.

Knowlton A.R. and S.D. Kraus. 2001. "Mortality and serious injury of northern right whales (*Eubalaena glacialis*) in the western North Atlantic Ocean". Journal of Cetacean Research and Management, Special Issue 2:193-208.

Kraus, S. D., R. D. Kenney, A. R. Knowlton, and J. N. Ciano. 1993. Endangered Right Whales of the Southwestern North Atlantic. Final Report, Contract No. 14-35-0001-30486. U. S. Department of the Interior, Minerals Management Service, Herndon, Virginia. 69 pp.

Laist, D.W., A.R. Knowlton, J.G. Mead, A.S. Collet, and M. Podesta. 2001. Collisions between ships and whales. Marine Mammal *Science 17 (1), 35–75. Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, Halichoerus* grypus, in the Northwest Atlantic. Can. Field-Nat. 115(4): 653-662.

Lesage, V. and M.O. Hammill. 2001. The status of the grey seal, Halichoerus grypus, in the Northwest Atlantic. Can. Field-Nat. 115(4): 653-662.

NatureServe. 2010. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available http://www.natureserve.org/explorer. Accessed: January 5, 2010

Nelson, M., M. Garron, R.L. Merrick, R.M. Pace and T.V.N. Cole. 2007. Mortality and serious injury determinations for large whale stocks along the United States Eastern Seaboard and Adjacent Canadian Maritimes, 2001-2005. U. S. Dep. Commer., Northeast Fish. Sci. Cent. Ref. Doc. 07-05. 18 pp.

Newcombe, C.P. and J.O. Jensen. 1996. Channel Suspended Sediment and Fisheries: A synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management 16:693-727. American Fisheries Society 1996.

NMFS (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 1991a. Recovery Plan for the Northern Right Whale (*Eubalaena glacialis*). Prepared by the Right Whale Recovery Team for the National Marine Fisheries Service", Silver Spring, Maryland. 86 pp.

NMFS. 1991b. Recovery Plan for the Humpback Whale (*Megaptera novaeangliae*). Prepared by the Humpback Whale Recovery Team for the National Marine Fisheries Service", Silver Spring, Maryland. 105 pp.

NMFS. 2006. Recovery Plan for The Sperm Whale (*Physeter macrocephalus*) [Draft Report]. (pp. 92). Silver Spring, MD: National Marine Fisheries Service.

NMFS. 2009. Sperm Whale (Physeter macrocephalus): 5-Year Review: Summary and Evaluation. (pp. 41). Silver Spring, MD: National Marine Fisheries Service.

NMFS. 2012. NMFS Office of Protected Resources Gray Seal (Halichoerus grypus) species profile. Accessed September, 2012, at: http://www.nmfs.noaa.gov/pr/species/mammals/pinnipeds/grayseal.htm

NOAA (National Oceanic and Atmospheric Administration). 1993. Stellwagen Bank Management Plan and Final Environmental Impact Statement. http://stellwagen.noaa.gov/management/1993plan.html.

NOAA. 1995. "Small Takes of Marine Mammals incidental to Specified Activities; Offshore Seismic Activities in Southern California," Federal Register 60 (No 200), 53753-53760.

NOAA. 1999. "Small Takes of Marine Mammals Incidental to Specified Activities; Seismic Hazards Investigation in Southern California," Federal Register 64 (No 112).

NOAA. 2005. Marine Mammal Protection Act (MMPA) of 1972. Office of Protected Resources.

NOAA. 2006. "Small Takes of Marine Mammals Incidental to Specified Activities; Rim of the Pacific (RIMPAC) Antisubmarine Warfare (ASW) Exercise Training Events Within the Hawaiian Islands Operating Area (OpArea)," Federal Register 71 (No.78).

NOAA. 2008. High numbers of right whales seen in Gulf of Maine: NOAA researchers identify wintering ground and potential breeding ground. NOAA press release; December 31, 2008.

NOAA. 2010. Reducing Ship Strikes to North Atlantic Right Whales. http://www.nmfs.noaa.gov/pr/shipstrike/.

NOAA. 2014a . Incidental Harassment Authorization to the Construction of the Deepwater Wind Block Island Transmission System, August 22, 2014.

NOAA. 2014b . Incidental Harassment Authorization to the Construction of the Deepwater Wind Block Wind Farm, September 3, 2014.

NOAA Fisheries. 2015. Office of Protected Resources, Marine Mammal Stock Assessment Reports. (SARs) by Species/Stock http://nefsc.noaa.gov/publications/tm/tm231/7_rightwhale_F2014July.pdf Accessed November 3, 2015.

Nowak, R.M. 2002. Walker's Mammals of the World 6th edition. John Hopkins University Press, Baltimore, MD.

NYDOS (New York Department of State). 2013. Offshore Atlantic Ocean Study. http://docs.dos.ny.gov/communitieswaterfronts/ocean_docs/NYSDOS_Offshore_Atlantic_Ocean_Study.pdf

OSPAR. 2008. Assessment of the environmental impact of offshore wind farms. Available at: http://qsr2010.ospar.org/media/assessments/p00385_Wind-farms_assessment_final.pdf

Pittman, S., B. Costa, C. Moy, D. Wiley, and R. D. Kenney. 2006. Cetacean distribution and diversity. 265-326 pp. In T. Battista, R. Clark, and S. Pittman, eds. An Ecological Characterization of the Stellwagen Bank National Marine Sanctuary Region: Oceanographic, Biogeographic, and Contaminants Assessment. NOAA Technical Memorandum NCCOS 45. Center for Coastal Monitoring and Assessment, NOAA National Centers for Coastal Ocean Science, Silver Spring, MD.

Porter, M.B., and Y.-C. Liu. 1994. Finite-element ray tracing. In: Lee, D. and M.H. Schultz (eds.). Proceedings of the International Conference on Theoretical and Computational Acoustics. Volume 2. World Scientific Publishing Co. pp. 947-956.

Reeves, R.R. and A.J. Reed. 2003. Bottlenose dolphin, harbor porpoise, sperm whale and other toothed cetaceans Tursiops truncates, Phocoena phocoena,a nd Physeter macrocephalus). Pp. 397-424 in Wild mammals of North American biology, management and conservation. (G.A. Feldhamer, B.C. Thomspon and J.A. Chapman, eds.). Johns Hopkins Univ. Press, Baltimore.

Reeves, R.R. G.K. Silber and P.M. Payne. 1998. "Draft recovery plan for the Fin Whale (*Balaenoptera physalus*) and Sei Whale (*Balenoptera borealis*)." Office of Protected Resources, National Marine Fisheries Service, Silver Spring, MD. 65pp.

Reeves, R.R., B.S. Stewart, P.J. Clapham, and J.A. Powell. 2002. Guide to Marine Mammals of the World. National Audubon Society.

Rice, D.W. 1998. Marine Mammals of the World: Systematics and Distribution D. Wartzok (Ed.), (Society for Marine Mammology Special Publication 4, pp. 231). Lawrence, KS: Allen Press.

Richardson, W.J, C.R. Greene, Jr., C.I. Malme, and D.H. Thomson with S.E. Moore and B. Wursig. 1991. Effects of noise on marine mammals. OCS Study MMS 90 0093. Report from LGL Ecol. Resl. Assoc. Inc., Bryan, TX for U.S. Minerals Management Service, Atlantic OCS Region, Herndon, Virginia. NTIS PB91 168914.

RI Ocean SAMP. 2011. Rhode Island Coastal Resources Management Council. Draft, May 4, 2010.

Right Whale Consortium. 2014. North Atlantic Right Whale Consortium Sightings Database. 03/11/2014. New England Aquarium, Boston, MA. USA.

Ronald, K., and B. L. Gots. 2003. Seals: Phocidae, Otariidae, and Odobenidae. Pp. 789–854 in: G. A. Feldhamer, B. C. Thompson, and J. A. Chapman, eds. Wild Mammals of North America: Biology, Management, and Economics, second edition. Johns Hopkins University Press, Baltimore, MD.

Rough, V. 1995. Gray Seals in Nantucket Sound, Massachusetts, Winter and Spring, 1994. Final Report to Marine Mammal Commission in Fulfillment of Contract T10155615.

Schroeder, C. L. 2000. Population Status and Distribution of the Harbor Seal in Rhode Island Waters. M.S. thesis. University of Rhode Island, Graduate School of Oceanography, Narragansett, RI. xiii + 197 pp.

Sergeant, D.E. 1977. Stocks of fin whales *Balaenoptera physalus* L. in the North Atlantic Ocean. Rep. int. Whal. Commn 27:460B473.

Shoop, C. R., and R. D. Kenney. 1992. Distributions and abundances of loggerhead and leatherback sea turtles in northeastern United States waters. Herpetological Monographs 6:43–67.

Stevick, P.T., L. Pacheco de Godoy, M. McOsker, M.H. Engel, J. Allen. 2006. A note on the movement of a humpback whale from Abrolhos Bank, Brazil to South Georgia. J Cetacean Res Manage 8:297-300

Sutcliffe M.H., and P.F. Brodie. 1977. Whale distributions in Nova Scotia waters. Fish Mar Serv Tech Rep 722:1-89.

Swingle, W.M., S.G. Barco, T.D. Pitchford, W.A. McLellan, and D.A. Pabst. 1993. Appearance of juvenile humpback whales feeding in the nearshore waters of Virginia. Mar. Mamm. Sci. 9:309-315.

Tetra Tech. 2014. Hydroacoustic Survey Report of Geotechnical Activities Virginia Offshore Wind Technology Advancement Project (VOWTAP) September 2014.

Waring, G.T., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2015. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Sssessments - 2014. NOAA Technical Memorandum. Available at: http://www.nmfs.noaa.gov/pr/sars/pdf/atl2014_final.pdf

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds). 2013. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2012, 419 pages. Available at: www.nmfs.noaa. gov/pr/sars/pdf/ao2012.pdf.

Waring, G., E. Josephson, K. Maze-Foley, and P.E. Rosel (eds.). 2011. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments - 2011, 330 pages. Available at: http://www.nmfs.noaa.gov/pr/pdfs/sars/ao2011.pdf.

Waring, G. T., Josephson, E., Maze-Foley, K. & Rosel, P. E. (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2009 [Technical Memorandum]. (NMFS NE 213, pp. 528). Woods Hole, MA: NOAA Retrieved from http://www.nefsc.noaa.gov/nefsc/ publications/tm/tm213/index.html

Waring GT, Josephson E, Maze-Foley K, and Rosel PE (eds.). 2010. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2009. NOAA Tech Memo NMFS NE 213; 528 p.

Waring, G.T., E. Josephson, C.P. Fairfield, and K. Maze-Foley, eds., with contributions from: Dana Beldon, Timothy V. N. Cole, Lance P. Garrison, Keith D. Mullin, Christopher Orphanides, Richard M. Pace, Debra L. Palka, Marjorie C. Rossman, and Fredrick W. Wenzel. 2007. Technical Memorandum NMFS-NE-201. National Oceanic and Atmospheric Administration, U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments – 2006.

Waring, G.T., E. Josephson, C.P. Fairfield-Walsh, and K. Maze-Foley (eds.). 2009. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments -- 2008. NOAA Tech Memo NMFS NE 210; 440 p.

Waring, G.T., L. Nøttestad, E. Olsen, H. Skov, and G. Vikingsson. 2008. Distribution and density estimates of cetaceans along the mid-Atlantic ridge during summer 2004. J Cetacean Res Manage 10:137-46.

Waring, G.T., R.M. Pace, J.M. Quintal, C.P. Fairfield, and K. Maze-Foley (eds.). 2004. U.S. Atlantic and Gulf of Mexico Marine Mammal Stock Assessments—2003. NOAA Technical Memorandum NMFS-NE-182.

Watkins, W.A., K.E. Moore, J. Sigurjonsson, D. Wartzok, and G. Notarbartolo di Sciara. 1984. Fin whale (Balaenoptera physalus) tracked by radio in the Irminger Sea. Rit Fiskideildar 8(1):1-14

Whitehead, H., S. Brennan, and D. Grover. 1992. Distribution and behaviour of male sperm whales on the Scotian shelf. Canadian Journal of Zoology 70, 912-918.

Whitehead, H. 2003. Sperm Whales: Social Evolution in the Ocean (pp. 431). University of Chicago Press.

Whitehead, H. 2008. Sperm whale *Physeter macrocephalus*. In W. F. Perrin, B. Wursig and J. G. M. Thewissen (Eds.), Encyclopedia of Marine Mammals (Second Edition) (pp. 1091-1097). Academic Press.

Wilber, D.H., and D.G. Clarke. 2001.Biological Effects of Suspended Sediments: A review of Suspended Sediment Impact on fish and Shellfish with Relation to Dredging Activities. North American Journal of Fisheries Management 21:855-875. American Fisheries Society 2001.

Winn, H. E., C. A. Price, and P. W. Sorensen. 1986. The distributional ecology of the right whale *Eubalaena glacialis* in the western North Atlantic. Reports of the International Whaling Commission, Special Issue 10: 129–138.

World Wildlife Fund. 2005. “Green Turtle: Introduction”. Site visited February 22, 2005.http://www.panda.org/about_wwf/what_we_do/species/showspecies.cfm?SID=32& LID=2&FH=E.

Wynne, K., and M. Schwartz. 1999. Marine Mammals and Turtles of the U. S. Atlantic and Gulf of Mexico. Rhode Island Sea Grant. Narragansett, Rhode Island. 114 pp.

Appendix A

Bay State Wind Offshore Wind Farm – Hydroacoustic Assessment of Drill Ship Thruster Use during Geotechnical Surveys

Appendix B

Bay State Wind Offshore Wind Farm – Mitigation and Monitoring Communications Flow Diagram

Appendix A

Bay State Wind Offshore Wind Farm – Hydroacoustic Assessment of Drill Ship Thruster Use during Geotechnical Surveys

1.0 Introduction

Bay State Wind LLC, “the Applicant” is proposing to conduct marine site characterization surveys off the coast of Massachusetts in the area of the Commercial Lease of Submerged Lands for Renewable Energy Development on the Outer Continental Shelf (OCS-A 0500) (the Lease; Figure 1-1). The purpose of the marine surveys is to:

- Support the siting, design, and deployment of up to two meteorological data collection buoys referred to as floating light and detection ranging buoys (FLIDARs) and up to two metocean and current buoys; and
- Obtain a baseline assessment of seabed conditions in the DONG Energy Massachusetts Lease Area (Lease Area) to support the siting of the proposed wind farm.

The Lease Area is presented in Figure 1-1.

The marine site characterization surveys will be comprised of two programs: a high-resolution (HRG) geophysical survey to be conducted in the spring of 2016; and geotechnical surveys to be conducted in the fall of 2016.

The document assesses the potential underwater noise produced by the geotechnical survey operations, namely the use of a dynamically positioned (DP) drill ship, so that an appropriate mitigation plan may be established. An assessment of the underwater noise produced by HRG survey activities was provided under separate cover.

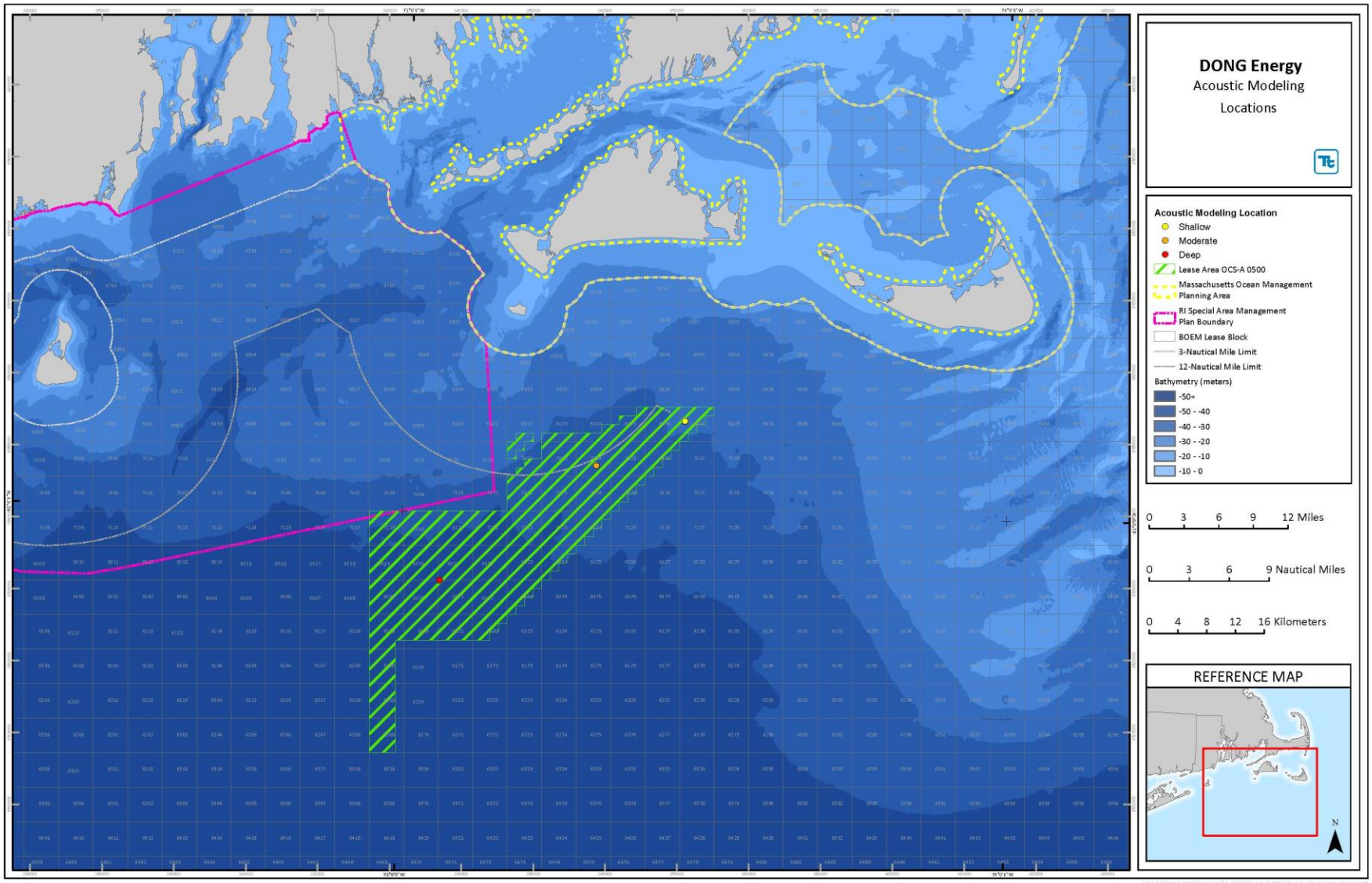

Figure 1-1 Project Overview Map

2.0 Description of the Proposed Activity

Geotechnical investigations will be conducted following the results of the HRG surveys and will include the following activities:

- Sample boreholes to determine geological and geotechnical characteristics of sediments;
- Deep cone penetration tests (CPTs) to determine stratigraphy and in-situ conditions of the deep surface sediments;
- Shallow CPTs to determine stratigraphy and in-situ conditions of the near surface sediments; and
- Vibrocoring to determine geological and geotechnical characteristics of the near surface sediments.

It is anticipated that the geotechnical investigations will take place in September of 2016. The geotechnical investigation program will consist of up to 4 deep sample boreholes and adjacent 4 deep CPTs both to a depth of approximately 40 to 50 m below the seabed, 15 shallow CPTs and adjacent 15 vibrocores both to a depth of 6 m below seabed.

The investigation activities are anticipated to be conducted from a 250- to 350-ft DP drill ship. To minimize the period of potential impact on marine species, as well as reduce duration and costs, geotechnical investigation operations will take place continuously over a 24-hour period. Based on 24-hour operations, the estimated duration of the investigation activities would be approximately 6 days excluding weather down time. Estimated weather down time is approximately 4 to 5 days.

Field studies conducted off the coast of Virginia (Tetra Tech 2014) to measure the underwater noise produced by borehole drilling and CPTs determined that these geotechnical activities, do not add appreciably to the underwater acoustic environment. However, the underwater noise produced by the thrusters associated with the DP vessel supporting the geotechnical activities has the potential to result in Level B Harassment of marine mammals. The following assessment evaluates the potential underwater noise produced by a representative DP drill ship that may be used to support the Project's geotechnical investigation and compares them against the National Oceanic and Atmospheric Administration (NOAA), National Marine Fisheries Service (NMFS) regulatory thresholds for harm (Level A Harassment) and behavioral disturbance (Level B Harassment) as defined under the Marine Mammal Protection Act (MMPA) for marine mammals as well as the interim NMFS guidelines for sea turtles.

3.0 Regulatory Overview

The potential effects of underwater noise on marine mammals are federally managed by the National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) under the Marine Mammal Protection Act (MMPA) to minimize the potential for both harm and harassment. Under the MMPA, Level A harassment is statutorily defined as any act of pursuit, torment, or annoyance that has the potential to injure a marine mammal or marine mammal stock in the wild; however, the actionable sound pressure level is not identified in the statute. The NMFS defines the Level A Harassment zone of injury to marine mammals as occurring at a sound exposure limit threshold of received sound pressure levels of 180 decibels (dB) referenced to 1 microPascal (µPa) root mean square (RMS), for both mysticetes and odontocetes, and 190 dB_{RMS} re 1µPa for pinnipeds. This threshold considers instantaneous sound pressure levels (SPLs) at a given receiver location.

The MMPA defines Level B harassment as any act of pursuit, torment, or annoyance that has the potential to disturb a marine mammal or marine mammal stock in the wild by causing disruption of behavioral patterns, including, but not limited to, migration, breathing, nursing, breeding, feeding, or sheltering. The NMFS has defined the threshold level for Level B harassment at 120 dB_{RMS} re 1 µPa for continuous noise and 160 $dB_{RMS90\%}$ re 1 µPa for impulse noise. In zones where received sound levels exceed these thresholds, project sound may approach or exceed

ambient sound levels (i.e., threshold of perception or zone of audibility); however, actual perceptibility will be dependent on the hearing thresholds of the species under consideration and the inherent masking effects of ambient sound levels.

Table 3-1 summarizes the definition of Level A and Level B Harassment for underwater noise as defined by the NMFS. These criteria levels are the regulatory thresholds used by NMFS under the ESA and MMPA to determine the potential for "take" by acoustic harassment. DP thrusters are considered a continuous noise.

Table 3-1 NMFS Marine Mammal Noise Criteria (NMFS, 2005)

	Criteria Level	Type
Marine Mammals		
Level A Harassment (Injury) - Mysticetes and Odontocetes	180 dB_{RMS} re 1 µPa	Absolute
Level A Harassment (Injury) - Pinnipeds	190 dB_{RMS} re 1 µPa	Absolute
Level B Harassment (Disturbance)	160 dB $re_{RMS90\%}$ 1 µPa 120 dB_{RMS} re 1 µPa	Impulse Continuous

Impact to sea turtles are federally managed under the Endangered Species Act (ESA). The hearing capabilities of sea turtle are poorly known and there is little information available on the effects of noise on sea turtles. Some studies have demonstrated that sea turtles have fairly limited capacity to detect sound, although all results are based on a limited number of individuals and must be interpreted cautiously. Limited research has shown that upper limit of the hearing range of sea turtles is generally in range 1,000 to 1,200 hertz (Hz) (Tech Environmental, 2006; Martin et al., 2012). BOEM states the hearing sensitivity of most sea turtles appears to be best at frequencies between about 200 Hz and 700 Hz (BOEM, 2013).

McCauley et al. (2000) serves as the best available information on the levels of underwater noise that may produce a startle, avoidance, and/or other behavioral or physiological response in sea turtles. McCauley noted that received decibel levels of 166 dB_{RMS} re 1µPa were required before any behavioral reaction (e.g., increased swimming speed) was observed, and decibel levels above 175 dB_{RMS} re 1µPa elicited avoidance behavior of sea turtles. This study used impulsive sources of noise (e.g., air gun arrays) to ascertain the underwater noise levels that produce behavioral modifications in sea turtles.

Based on this and the best available information (BOEM, 2012a, b; Popper et al., 2014), the NMFS believes any sea turtles exposed to received underwater noise greater than 166 dB_{RMS} re 1µPa may experience behavioral disturbance/modification (e.g., movements away from ensonified area) and at received levels greater than or equal to 207 dB_{RMS} re 1 µPa have the potential to cause injury. Table 3-2 summarizes the present NMFS interim guidelines on underwater noise level which have the potential to cause injury or behavioral modification of sea turtles.

Table 3-2 NMFS Interim Underwater Noise Criteria for Sea Turtles

	Criteria Level	Functional Hearing Range
Sea Turtles		
Injury	207 dB_{RMS} re 1 µPa (RMS)	Up to 1.2 kHz (est.)
Behavioral Disturbance	166 dB_{RMS} re 1 µPa (RMS)	Up to 1.2 kHz (est.)

4.0 Methodology

Acoustic modeling of the DP drill ship was completed based on a version of the U.S. Naval Research Laboratory's Range-dependent Acoustic Model (RAM) (Porter and Liu, 1994). RAM is widely used by sound engineers and marine biologists due to its adaptability to describe highly complex acoustic scenarios. RAM is based on the parabolic equation (Collins, 1993) method using the split-step Padé algorithm for improved numerical accuracy and efficiency in solving range dependent acoustic problems and has been extensively benchmarked (Collins et al., 1996). The modeling methodologies employed calculate transmission loss based on a number of factors including the distance between the source and receiver along with basic ocean sound propagation parameters (e.g., depths, bathymetry, sediment type, and seasonal sound speed profile). For each sound source, modeling was performed along transects originating out from the source along compass points (45°, 90°, 135°, 180°, 225°, 270°, 315°, and 360°) and propagating horizontally. The received sound field within each radial plane was then sampled at various ranges and depths from the source with fixed steps. The received sound level at a given location along a given transect was then taken as the maximum value that would occur over all samples within the water column.

These values were then summed across frequencies to provide broadband received levels at the MMPA marine mammal and interim sea turtle Level A and B harassment criteria as described in Tables 3-1 and 3-2.

5.0 Modeling Assumptions

To evaluate effects from the operation of the DP thrusters, representative sound source data were reviewed to estimate a representative thruster source level of 177 dB_{RMS} re 1 µPa, which is dependent on the hydrodynamic and hydroacoustic design and depth of the thrusters on the vessel, and by power output (horsepower [HP]). The exact vessel is not currently known, so surrogate vessels have been considered. The survey is expected to commence in September, when weather in the Lease Area is still expected to be favorable. The source level used in the assessment was adjusted to account for the actual expected power output of the DP thrusters, which is anticipated to be no more than 50 percent. This was accomplished by using the representative sound source level of the DP thruster at a 100 percent power output and then logarithmically scaling it to account for the anticipated power output. The logarithmic scale is considered conservative as it calculates an equal amount of percentage change between the source levels as they relate directly to power output, rather than attempting to determine the onset of cavitation for a vessel's thrusters[1], which cannot be accurately quantified and is often variable. A sound level of 174 dB_{RMS} re 1µPa was used for a modeled source level. Measured levels for a given vessel can vary significantly, with values being 5-10 dB above and below apparent source levels. Zones of influence were calculated by assuming thrusters fired simultaneously in all radial directions, although these sound sources are directional by nature.

Seasonality within sound speed profiles can have a significant impact on sound propagation. In the Lease Area, the water depth is not sufficient to form a deep sound channel, and sound speed is strongly affected (and hence propagation) by seasonal and daily water temperature changes with depth. The speed of sound in sea water is dependent on the temperature T [°C], salinity S [ppt], and depth D [m]. Water column sound speed profiles (SSPs) were described from profiles downloaded from the U.S. Naval Oceanographic Office's (2003) Generalized Digital Environmental Model (GDEM) database. For acoustic modelling, the sound speed profile for September was evaluated.

[1] Cavitation is the primary noise generated during thruster use.

To be conservative, hydroacoustic modeling calculations were completed at three representative locations at water depths of 38 m, 44 m, and 54 m within the Lease Area to capture variability in seafloor conditions. Bathymetry and sediment type can have a significant impact on sound propagation. The modeling scenarios with the longest ranges were used to determine zones of influence.

6.0 Results

For DP thruster use, the ensonified area at the 120-dB_{RMS} re 1 µPa isopleth was modeled at three representative water depths (38 m, 44 m, and 54 m) within the Lease Area. The NMFS marine mammal Level B harassment criterion for continuous noise is 120 dB_{RMS} re 1µPa. Results of the analysis showed that at all depths, the estimated maximum critical distance to the marine mammal 120 dB_{RMS} re 1 µPa MMPA threshold ranged from 2,600 to 3,400 m from the source (see Table 6-1) depending on modeling location and transect direction. The distance to the 166 dB_{RMS} re 1 µPa RMS harassment zone for sea turtles at all water depths was negligible, and less than 5 m.

As shown in Table 6-1, DP thrusters will not produce sound levels to the 180 dB_{RMS} re 1 µPa marine mammal Level A harassment threshold or 207 dB sea turtle injury threshold at any appreciable distance to the vessel. Distances to the aforementioned thresholds will be verified prior to survey based on the actual DP drill ship selected by the Project to perform the survey.

Table 6-1 Worst-Case Modeled Distances to MMPA Thresholds for Maine Mammals and NMFS Interim Guidelines for Sea Turtles in Meters

	Marine Mammal Level A Harassment 180 dB_{RMS} re 1 µPa	Marine Mammal Level B Harassment 120 dB_{RMS} re 1 µPa	Sea Turtle Injury 207 dB dBRMS re 1 µPa	Sea Turtle Behavioral Modification 166 dB_{RMS} re 1 µPa
DP Thrusters	-	3,400	-	< 5

7.0 References

BOEM (U.S. Department of the Interior, Bureau of Ocean Energy Management). 2012a. Effects of Noise on Fish, Fisheries, and Invertebrates in the U.S. Atlantic and Arctic from Energy Industry Sound-Generating Activities, Literature Synthesis.

BOEM. 2012b. Underwater hearing sensitivity of the leatherback sea turtle (Dermochelys coriacea): Assessing the potential effect of anthropogenic noise. Office of Renewable Energy Programs. OCS Study BOEM 2012-01156

BOEM. 2013. NOAA's National Marine Fisheries Service Endangered Species Act Section 7 Consultation: Biological Opinion.

Collins, M.D. 1993. The split-step Padé solution for the parabolic equation method. *The Journal of the Acoustical Society of America* 93:1736-1742.

Collins, M.D., R.J. Cederberg, D.B. King, and S.A. Chin-Bing. 1996. Comparison of algorithms for solving parabolic wave equations. Journal of the Acoustical Society of America 100:178-182

NMFS (National Oceanic and Atmospheric Administration, National Marine Fisheries Service). 2005. Endangered Fish and Wildlife: Notice of Intent to Prepare an Environmental Impact Statement. National Marine Fisheries Service. Federal Register 70:1871-1875.

NMFS. 2013. Draft Guidance for Assessing the Effects of Anthropogenic Sound on Marine Mammals: Acoustic Threshold Levels for Onset of Permanent and Temporary Threshold Shifts. Available online at http://www.nmfs.noaa.gov/pr/acoustics/draft_acoustic_guidance_2013.pdf, viewed April 10, 2014.

Marine Mammal Monitoring Surveys by Statoil E&P Inc in the Chukchi Sea, August-October 2011: 90-Day Report. http://www.nmfs.noaa.gov/pr/pdfs/permits/statoil_90day_report2011.pdf viewed October 26, 2015.

Martin, K.J., S.C. Alessi, J.C. Gaspard, A.D. Tucker, G.B. Bauer, and D.A. Mann. 2012. Underwater hearing in the loggerhead turtle (Caretta caretta): a comparison of behavioral and auditory evoked potential audiograms. The Journal of Experimental Biology 215:3001-3009.

Popper, Arthur N., Anthony D. Hawkins, Richard R. Fay, David Mann, Soraya Bartol, Thomas Carlson, Sheryl Coombs, William T. Ellison, Roger Gentry, Michele B. Halvorsen, Svein Lokkeborg, Peter Rogers, Brandon L. Southall, David G. Zeddies, and William N. Tavolga. 2014. ASA S3/SC1.4 TR-2014 Sound Exposure Guidelines for Fishes and Sea Turtles: A Technical Report prepared by ANSI-Accredited Standards Committee S3/SC1 and registered with ANSI, ASA Press.

Porter, M.B., and Y.-C. Liu. 1994. Finite-element ray tracing. In: Lee, D. and M.H. Schultz (eds.). Proceedings of the International Conference on Theoretical and Computational Acoustics. Volume 2. World Scientific Publishing Co. pp. 947-956.

Talisman Energy (2006) Beatrice Wind Farm Demonstrator Project: Environmental Impact Statement. Talisman Energy (UK) Ltd.

Tech Environmental, Inc. 2006. Final EIR Underwater Noise Analysis. Tech Environmental, Inc. (Report 5.3.2-2). Waltham, Massachusetts.

Tetra Tech. 2014. Hydroacoustic Survey Report of Geotechnical Activities Virginia Offshore Wind Technology

Advancement Project (VOWTAP) September 2014.